ONE TWENTY FIVE HIGH STREET

Final Environmental
Impact Assessment

ONE TWENTY FIVE HIGH STREET
FINAL ENVIRONMENTAL
IMPACT ASSESSMENT

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Prepared for:

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ENVIRONMENTAL IMPACT ASSESSMENT

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1.0 PREFACE

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This Environmental Impact Assessment is prepared in accordance with the Boston Redevelopment Authority's Development Review Procedures, dated 1985, revised 1986, and, specifically, in response to the August 13, 1986 scope for the proposed One Twenty Five High Street development. Comments on the Draft EIA, received during the comment period, have been incorporated into this Final EIA. The project proponent is The Prospect Company, on behalf of a limited partnership to be formed by The Prospect Company, New England Telephone and Telegraph Company, and Spaulding and Slye Company. This report was prepared by HMM Associates, Inc. The Transportation Impacts/Access Plan was prepared by Vanasse/Hangen and the wind impact analysis was prepared by David Surry, Associate Research Director at the University of Western Ontario. The project architect, Jung/Brannen Associates, Inc., provided the chapter on design and aesthetics as well as several of the drawings, renderings, and photographs used in this report.

2.0 EXECUTIVE SUMMARY

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One Twenty Five High Street is a major, mixed-use project to be constructed at Fort Hill Square in Boston's financial district. The project entails the redevelopment of one of the last large, feasible building sites in the City's financial district. The plans provide for building approximately 1.4 million square feet of new above-grade construction on a 2-1/2 acre site, while retaining three 19th century buildings deemed to be of historical and architectural value. The completed project will provide for first-class office space appropriate to the location and a new City of Boston fire station and a separate ambulance facility. The office space will be augmented by ground level activities that include retail and/or restaurant space, lobbies, interior pedestrian passageways and a climate-controlled atrium accessible to the public. Below the mixed-use development there will be a new parking garage providing approximately 850 parking spaces, service and mechanical areas and off-street loading docks.

The site for One Twenty Five High Street is the city block bounded by High Street and the State Street Bank and the Telephone Company buildings to the north, Oliver Street and International Place to the east, Purchase Street to the south, and Pearl Street to the west. The block is a suitable site for high density development both because of its location in the financial district, and because of its immediate proximity to the major roadways and public transportation systems that converge at South Station. The 2-1/2 acre site currently contains the 16-story Travelers Building, a glazed brick building erected in 1958, and the ground level parking and plaza areas that surround it. The other parcels comprising the development site are a small, vacant, City-owned parcel at the intersection of High and Oliver Streets, a two-story City of Boston fire station with frontage on Oliver Street, and three vacant 19th century buildings at the corner of Oliver and Purchase Streets. In total these structures represent

significant under-utilization of downtown Boston commercial property. Site preparation will include renovating the three 19th century buildings including an ambulance facility, razing the Travelers Building, and replacing the fire station with a new facility located within the development and with frontage on Purchase Street, and thereafter razing the existing fire station.

The major design elements of One Twenty Five High Street include a 30-story office/retail building to be built on the western side of the site, and a 21-story office/retail building at the northeastern corner along Oliver Street. The site design is integrated by the introduction of an infill base structure, varying in height from three to nine stories. The infill base provides a transition between the two larger buildings as well as incorporating the new fire station and the three renovated buildings into a single, compatible layout for the site. The infill base includes a large landscaped, climate-controlled atrium and much of the retail space included in the project. The parking garage, with its estimated total of 850 spaces, is to be built on approximately six subsurface levels. Tentative plans are to provide 30 parking spaces for the Boston Fire Department, 7 parking spaces for the Boston ambulance facility, 150 public parking spaces, and 663 parking spaces for tenant use.

The exterior of all new construction will include glass, granite, and metal panels. The design of the buildings reflect early 20th century Boston architecture that makes use of building set backs, articulation to reduce apparent building mass, and the use of varied facade materials.

The proposed design is the result of a long and thorough design review process. It is the seventh design that has been compiled and presented informally to the Boston Redevelopment Authority (BRA). Through its evolution, the design and massing of the project have been refined and drastically reduced in scale. At the insistence of the City, maximum building heights have been reduced from an initial height of over 600 feet to the current height of 400 feet. The total area of One Twenty Five

High Street has been trimmed from an initial above-grade program of 1.75 million square feet to the current level of approximately 1.45 million square feet. The resulting design represents a commitment to preserve open air, pedestrian and vehicular access, and to reduce canyon effects in a densely developed area.

The project proponent anticipates a six-year construction schedule. Renovation of the three 19th century buildings is anticipated to begin in the spring of 1988. The first element of new construction is the 30-story building which will begin in the spring of 1988 as well. Subsequent aspects of the development will commence sequentially until the project is completed in the fall of 1992.

As an integral part of the design review process, the BRA has required the compilation of an Environmental Impact Assessment report (EIA) for One Twenty Five High Street. The project proponent has been directed to provide a detailed description of the project and its alternatives, and its potential for impacts in each of twelve topical areas, as follows:

- Transportation
- Wind
- Shadow
- Daylight
- Excavation/Soil Conditions
- Air Quality
- Noise
- Utility Systems
- Energy
- Historical Landmarks
- Design and Aesthetics
- Construction Methods

The data and analysis of each of these topics reveals that One Twenty Five High Street has limited potential for negative environmental impact. This is due, in large part, to the significant amount of effort directed toward mitigation of environmental impacts which is included in the current project design. Each successive scheme presented to the BRA over the past 18 months was developed to respond to specific concerns of the BRA with regard to potential impacts. Downsizing of the project has resulted in a concomitant reduction in potential impacts. In addition, project elements have been relocated on the site to minimize traffic conflicts and create opportunities for pedestrian amenities; heights have been reduced to minimize shadow impacts; an arcade provided to mitigate the existing windy environment; and the project reconfigured to retain several historically interesting buildings on the site. Each of these examples demonstrates the significant amount of mitigation included in the current building design, which has resulted in a project with limited potential for negative impacts.

One Twenty Five High Street will result in positive economic impacts. These will include employment opportunities, tax benefits, and linkage payments to the City of Boston. There will be both construction jobs and upon completion of the project, permanent employment created by the tenants occupying the new buildings. Approximately 630 jobs are predicted over the six year construction period and 4,700 permanent employment is predicted upon full occupancy of One Twenty Five High Street. In terms of tax benefits, the completed project will generate annual taxes of approximately $5.6 million. This is a significant increase over current annual taxes of $1.4 million. It is also projected that the City will receive approximately $7.5 million in linkage payments.

The following paragraphs summarize the findings in each of the areas of concern along with specific measures to mitigate potential impacts associated with the project.

Transportation

On a daily basis, the project is expected to generate 1,255 net new one-way vehicle trips (i.e., total project trips less existing trips). During peak hours, an estimated 436 and 445 new trips are projected during the inbound AM and outbound PM peaks, respectively. Seventeen intersections were analyzed with regard to traffic impacts. The addition of project-related traffic to 1994 No-Build volumes results in only one location that is projected to experience a change in peak hour Level of Service (LOS) from No-Build conditions. That intersection is at Oliver Street/Purchase Street which will decline from LOS "B" to LOS "C" in the morning peak hour and from LOS "A" to "B" in the evening peak hour. Levels of Service can range from "A" to "F"; LOS "B" and LOS "C" are considered acceptable levels of service. Volume-to-capacity ratios and delay values increase at six other locations while not changing level of service.

Between 1986 and 1994, rapid transit use is expected to increase by an average of almost 37 percent based on background growth in the Downtown area. The project will add a further increase of almost 2 percent. With the MBTA now in the final stages of improvements on both the Orange and Red Lines, an expansion from four-car to six-car trains is anticipated prior to 1994 on both lines. This, coupled with new equipment on the Green Line, will result in a substantial increase in transit capacity on those lines. However, under both No-Build and Build conditions, the Blue Line north, Orange Line north, and Green Line west will be over line capacity in 1994. All other lines will operate below capacity.

One Twenty Five High Street will include the construction of below-grade parking which is proposed to contain approximately 850 spaces, of which approximately 150 will be designated for public use, 30 for the Boston Fire Department and 8 for the Boston ambulance facility. The analysis suggests that the long-term commuter parking demand associated with the project will be 1,015 spaces. Short-term, non-employee demand is

expected to be 265 spaces at peak. This demand estimate may be somewhat high, as it is based on a conservative projection of mass transit use which is below that experienced at some buildings in the financial district.

The EIA includes a proposed Access Plan which identifies actions to reduce further the impact of development. Included in the Access Plan are commitments by the proponent to take steps to reduce and manage vehicular trip generation to the site and to design access to the building in order to minimize impacts on adjacent streets. Trip reduction efforts include measures to promote ridesharing and transit use, to encourage alternative work schedules, to restrict truck deliveries to non-peak hours, and to provide administrative support for trip reduction/management efforts.

The mitigation measures to which the proponent has committed include:

- Ride sharing - encouraging use of carpools and vanpools by providing an on-site ride matching program, provision of promotional materials, and coordination with Caravan or other similar vanpool providers.

- Public Transportation - encouraging use of mass transit by selling bus and MBTA passes on-site, promoting tenant subsidies, provision of bus and train schedules and other promotional material.

- Alternative Work Schedules - reducing peak-hour demands by promoting flex-time (currently in place at NET), providing off-hours building services.

- Parking Supply Management - parking spaces will be managed to reduce peak-hour trips, including preferred high occupancy vehicle (HOV) spaces and reserved spaces for off-peak arrivals.

- Delivery Vehicles - all deliveries and loading are accommodated off-street, with loading available 24-hours per day to encourage off-peak deliveries.

- Taxis - will determine a mutually agreeable taxi-stand location with the City.

- Pedestrian - pedestrian links improved around and through the site.

- Bicycle storage available.

- A transportation coordinator will be appointed on the building staff to monitor implementation of the Access Plan.

- Construction management will include protected pedestrian routes, on-site staging, police officer control as required, no construction worker parking, off-peak worker shifts.

Wind

Extensive wind tunnel modeling has served to confirm that the site, like most of Boston, is a relatively windy location. The wind study examined approximately 40 locations around the site, comparing existing conditions with the full development of One Twenty Five High Street. At about half of these study locations there were decreases in wind velocities resulting from the project. Of the other half that indicated increases, most showed modest increases ranging from 1 to 3 mph. The analysis of the project's final design demonstrated all gust wind speeds below the BRA's 31 mph criterion and also indicated no mean wind speeds in the unacceptable category.

The windiest location in the project area under the analysis of the project's most current design, was noted at the southern end of Oliver Street where gust velocities approached 28 mph. The wind tunnel study, however, indicated similar wind levels in this area under the current site configuration. This relatively windy area is not considered troublesome given its location between One Twenty Five High Street and International Place. This is in a pedestrian corridor for which there are suitable, attractive, alternate routes. Both abutting projects encourage pedestrians to use parallel interior pathways with full protection from the elements. Anyone subjected to high winds, therefore, has chosen the less protected environment as a matter of personal preference. Further, recent project design changes include a pedestrian arcade along Oliver Street to provide some protection to individuals finding it necessary to use this area.

In order to minimize the effects of wind levels around the project area, the following mitigation measures have been included in project design:

- Enclosed environmentally controlled atrium and retail area as opposed to the open area originally proposed.

- Inclusion of pedestal-like structures at the base of taller building elements to restrict downward deflected winds at pedestrian level.

- Provision of a pedestrian arcade around three quarters of the project to shelter pedestrians from downward deflected winds.

Shadow

Shadow diagrams have been compiled for morning, noon and afternoon for each season of the year. The diagrams show that there are very few areas in which the project will cast new shadows on pedestrian areas. For the most part new shadows are limited to High Street and Oliver Street and their sidewalks. The shadow impacts are limited by the location of the new buildings relative to other existing and planned buildings. Much of the shadow created by the project is superimposed upon shadows from International Place, the Telephone Company building, and the State Street Bank building. The shadow studies indicate that minimal new shadows resulting from One Twenty Five High Street will fall on a portion of the Custom House District mid through late autumn and early through mid spring. A small portion of the proposed Post Office Square park and its seating area will be affected for a short period during early morning in the fall and spring.

Building elements have been reduced in height and reconfigured on the site to minimize impacts to major public open spaces, particularly the proposed park at Post Office Square. In particular, the 600 foot tall tower originally proposed on the northeast corner of the site has been reduced to no more than 300 feet, reducing shadow impacts significantly. In addition, the north-south cross-section of the taller building has been narrowed, further mitigating shadow impacts.

Daylight

The analysis reveals that the present configuration of the buildings (the Travelers Building with its surface parking and open areas) results in very little obstruction of perceived daylight or "skydome" from any street surrounding the block. The viewable portion of skydome ranges from 23% to 45%. High Street shows the least obstruction and Pearl Street the most. This is due in part, to the narrowness of Pearl Street.

The proposed development represents an increase in massing on the 2-1/2 acre site. The new buildings are designed to maximize sheltered amenities with pedestrian arcades at street level, an interior landscaped atrium, and several entrances for pedestrians. This is achieved by placing the buildings near the property lines on all sides of the block. As a result, the skydome is reduced and the obstruction of perceived daylight at street level is increased from 14% to 49%. However, the provision of sheltered indoor amenities and skylights allowing views of the sky offsets in part the lost benefits of perceived skydome by pedestrians.

Daylight impacts of the proposed project are mitigated using step-backs at the upper building elevations, and breaking up of long-block facades into several discreet building elements.

Excavation/Soil Conditions

Subsurface exploration data indicate little potential for impacts associated with excavation. The probable soil and rock sequence of the site from ground level downward is miscellaneous fill, glacial deposits and bedrock. These materials will accommodate suitable foundations for the various elements of the project. There is no indication of potential for geological instability that could result in damage to abutting properties. The soils do not indicate a need for sophisticated or unusual construction techniques.

Although no significant excavation or subsurface impacts are expected, the following measures will be taken to minimize potential impacts:

- No continous pile driving will be undertaken. The foundation will be on pre-drilled soldier piles.

- Lateral support will be provided by tiebacks drilled and grouted in glacial till.

- Any pervious zones encountered during excavation will be dewatered and grouted to prevent further seepage.

- An underdrain system may be provided beneath the lowest floor slab. If so, it will be designed such that groundwater levels are not lowered in surrounding areas.

Air Quality

The proposed project will attract motor vehicles that emit pollutants regulated by state and federal standards. Studies of project generated emissions, however, indicate no contributions to violations of ambient air quality standards following mitigation considerations. Neither does the project contribute to significant deterioration of air quality. In fact, the air quality analysis predicts overall improvements in future air quality, as a result of the increased effectiveness of vehicular emissions controls, despite modest increases in local traffic.

The project will also be a source of fugitive dust emissions during construction. These emissions are predicted to result in no air quality problems. Construction management techniques to minimize dust during demolition and excavation are readily available. The project proponent is committed to implementing these techniques, which include:

- Following safety procedures and applicable regulations in preparing existing structures for demolition.

- Spraying dust-producing debris to reduce fugitive dust emissions.

Noise

Construction activities such as trucks removing demolition debris and excavation material from the site, the operation of earth moving equipment, and steel erection are expected to generate noise level increases in the immediate area. Despite noise increases due to construction-related activities, no significant adverse noise impacts are expected to occur because existing ambient noise levels in the area are already quite high in this dense urban business area.

After construction, noise generating activities will be those typical for large office buildings, that is, the operation of heating, ventilation, and air conditioning systems (HVAC). The noise from the Central Artery and busy urban street traffic is expected to mask the HVAC noise generated.

The fire station and ambulance facility on-site create a high level of noise when the fire trucks and ambulances respond to a call. The duration of the noise of the sirens is very brief. This type of noise is similar to that which currently exists on the site.

No negative noise impacts are expected during construction or operation of the project. No continuous pile driving is expected during construction.

Utility Systems

The project will result in increased demands for water and sewer service. An average water demand of 134,600 gallons per day (gpd) is predicted, while the average sewage generation for the project is estimated to be 122,400 gpd. These values represent an increase of about 100,000 gpd over the demands of the existing site activities in both cases.

Regarding water service, available information indicates that the existing Boston Water and Sewer Commission (BWSC) water supply and distribution system has ample capacity to satisfy the project demands for water service.

The analysis of the capacity of the sewer system to handle project demands is a somewhat more complex issue. The local BWSC sewer adjacent to the project site has sufficient design capacity to handle the design sanitary sewage flows from the project and other uses of this sewer (International Place). However, the major sewer interceptor which handles the downtown Boston and harborfront area (East Side Interceptor (ESI)) has well documented dry and wet weather capacity issues. The sewer system tributary to the ESI is a combined storm water and sanitary system. The system periodically overflows into the harbor, especially in wet weather. It is also subject to surcharging associated with tidal infiltration.

Fortunately, repairs to this system are presently underway including the construction of a completely new ESI. The new ESI is presently scheduled for completion sometime in 1989 or 1990, and is expected to be fully operational by the time the project is occupied. The new ESI is being designed to completely eliminate dry weather overflows to the inner harbor, and also to significantly reduce wet weather overflows. This will significantly improve the current water quality situation in the inner harbor. Allowance for current and potential future growth in sanitary flows has also been incorporated into the design of the new ESI, so that the system will have adequate capacity into the foreseeable future. The design margins for the new ESI system will normally also allow the interception of some or all of the combined sewer flows during wet weather conditions. The BWSC and Massachusetts Water Resources Authority (MWRA) intend to continue to pursue implementation of combined sewer overflow (CSO) mitigation strategies as needed, such as installing CSO treatment facilities as needed, to meet water quality goals for the inner harbor.

The project will also implement a number of significant mitigation measures to minimize impacts on the BWSC's sewer system. The basic design features of the project to minimize sewer impacts include:

- Use of the latest, most efficient plumbing fixtures including limited flow faucets and toilets.

- Use of a sewage retention tank with the capacity to store a normal workday's sanitary sewage. The tank will be equipped with a duplex pumping system and a programmable tide clock controller. Sanitary wastewater will be pumped into the combined sewer system only during periods of low tide. This will reduce loads on the system during high tide periods when surcharging caused by tidal inflow is a problem. This retention tank and low-tide pumping system is currently required by the BWSC for major development projects.

Since wet weather surcharging is currently a significant problem with the existing sewer system, and will not be completely eliminated by the construction of the new ESI, the project has established a design goal of reducing any additional flows to the combined sewer system under wet weather surcharge conditions. The following methods will be pursued to achieve this design goal:

- A separate 15" storm drain has been installed along Oliver Street by the developers of International Place. This separate storm drain system discharges directly to Boston Harbor rather than the ESI. The design of the site drainage for One Twenty Five High Street will seek to utilize as much excess capacity as is available in this separate 15" storm drain system so as to minimize the amount of storm flow from the project site into the ESI. Since the project's peak sanitary discharge is estimated to be about 18% of the peak combined flows, providing

separate storm drainage for about 22% of the 2.5 acre project site would completely offset the sanitary sewage pumping rate from the project under typical storm sewer design conditions.

- A manual override on the programmable pumping controller for the sewage retention tank will be provided if allowable by appropriate authorities. If wet weather surcharging conditions are being experienced during the normal low-tide pumping cycle, the building managers may be able to override the normal pumping cycle and discharge the sewage during the next low tide. This is normally possible since the tank is sized to hold a normal workday's sewage, and the pumps are capable of discharging the full tank capacity during a 4-hour low-tide period (2 hours each side of low-tide).

Energy

Attention to energy efficiency has been considered throughout the development of the project. The latest energy efficient technology will be incorporated into the design. Objectives identified have been to minimize building energy demands, to reduce summer solar gain, to minimize on-site fossil fuel consumption and to maximize energy efficiency. This will be accomplished by selecting energy-efficient glazing, proper insulation, an all-electric system, and by using advanced space lighting concepts. The resulting annual energy consumption is estimated to be 22 kilowatt hours per square foot, a reasonable level of demand for a project of this size, and a level well within the supply capabilities of Boston Edison.

Specific energy conservation measures include:

- Double glazed windows for thermal insulation.

- Use of high-efficiency lighting fixtures with local switching systems.

- Use of a variable air volume ventilation system which can balance inside and outside air volumes depending upon temperatures.

- Provision of a zoned HVAC system able to respond to local climate control demands.

Historical Impacts

The proposed project has been reconfigured since its original scheme in order to retain the three 19th century buildings of some historical interest. These are located at the corner of Purchase and Oliver Streets. These three structures, 4 to 6 stories in height, will be renovated. In addition, the overall design of the project is sensitive to nearby historic areas in its massing, use of materials, facade treatment and architectural detailing.

All buildings within the project area have been surveyed by the Boston Landmarks Commission. The Travelers Building and the existing fire station have been judged to be of no historical value. The three 19th century buildings have been ranked 3, 4, and 5 on a scale of 1-5 with the lowest numbers assigned to buildings of greatest merit by the Boston Landmarks Commission. None are listed in the National Register. The building ranked 5, will house the City of Boston ambulance facility on the first level. All three buildings will be integrated into the project and its uses. The renovation of both the exteriors and interiors of the three buildings is a positive impact of the project.

A number of historical properties and two historic districts are in the vicinity of the project. No direct impacts are expected on these resources and the indirect impacts are fairly limited. The limited impacts include the inconvenience associated with the six years of construction.

Design and Aesthetics

The design of One Twenty Five High Street has been based upon historical precedent for buildings in Boston's financial district, to harmonize not only with the immediate environment, but with the evolving character of the City. The early 20th century buildings which this design emulates are primarily characterized by their facing materials and the use of articulation to reduce the apparent mass. The choice of facing for the proposed structures has been based upon an extensive study of the materials typically utilized in the area, so the new construction will be compatible with materials used in other buildings on surrounding blocks. The mass reduction effect is provided by locating the 30-story building on the western side of the block, and the 21-story building on the northeastern side, which preserves the existing rhythm of height variation. Additionally, both of the structures have been broken into smaller masses by using notches and setbacks.

The proposed structures do not exceed the heights of nearby buildings. They have been designed to provide a human scale experience, both visually and in terms of open space for pedestrian utilization. The resultant design is viewed by the project sponsors as a significant positive impact, particularly given the unappealing character of the site as it is today.

Construction Impacts

The construction of One Twenty Five High Street will involve the short-term construction impacts common to all major urban renewal activities. These include noise and fugitive dust during demolition activities; noise, fugitive dust, and impediments to traffic flow during excavation; and the impacts associated with the operation of heavy equipment and with construction deliveries throughout the construction period. The

impacts anticipated are typical construction phase impacts. No intrusive construction practices are foreseen (e.g., blasting, extensive pile driving or unusual construction scheduling).

The potential for construction impacts will be mitigated both by appropriate construction management techniques and by the site location. The site location has two major advantages. First, it is adjacent to the Central Artery. This means that construction traffic will travel through neither residential neighborhoods, nor through the narrow downtown street system. Second, the site is buffered from sensitive receptor areas. There are no residential areas, public institutions or public open space areas within the area that will be directly affected by construction activity.

Measures to mitigate construction impacts include the following:

- Safety precautions (sealing-off area, careful preparation of building) and warning to persons in the area if implosion is selected for demolition.
- Spraying of debris to reduce fugitive dust emissions.
- Immediate street cleaning following implosion, if applicable.
- Traffic control as provided for in the Access Plan.
- Careful preparation of existing structures according to applicable regulations prior to demolition.

Conclusions

The design of One Twenty Five High Street has evolved through a complex design process. Many of the refinements have resulted in direct or indirect mitigation of potential impacts. For example the BRA has insisted on design modifications and reductions in height by approximately 33% and massing for the

project. These changes have resulted in a broad range of mitigating effects. The reductions in scale have reduced potential for wind and shadow, reduced demands for utilities, reduced transportation demands, and improved the aesthetic harmony of the project elements with their surroundings.

Project sponsors have also compiled a transportation Access Plan. The plan includes commitments by the proponents to encourage all tenants to reduce and manage trip generation and vehicular circulation in the project area. The plan is included in the EIA.

The project includes designs for separating storm runoff and sanitary sewage. It also includes provision for on-site storage of sanitary sewage for timed release during low-tide, non-business hours. These measures have been adopted to minimize potential for adding to existing sewer system problems.

As a result of the extensive design and review process, the project involves few potential adverse environmental impacts. Potential impacts are particularly modest for a project of this size and scope. Mitigating measures have been designed to address those areas in which there is potential for project related impacts. The remaining impacts appear to be justified by the benefits associated with the project. Some of the benefits include the creation of jobs, both during construction and permanent employment created by the tenants occupying the completed project. Approximately 630 construction jobs are predicted over the next six years; permanent employment at the site is predicted to be 4,700 jobs.

The project will result in direct financial benefit to the City as well. The completed project will generate annual taxes of approximately $5.6 million annually. This is a significant increase from the current annual taxes of $1.4 million. The City will also be the direct recipient of approximately $7.5 million in linkage payments.

3.0 BOSTON REDEVELOPMENT AUTHORITY

BOSTON
REDEVELOPMENT
AUTHORITY

Raymond L. Flynn
Mayor

Stephen Coyle
Director

One City Hall Square
Boston MA 02201
(617) 722-4300

August 13, 1986

Mr. Brian K. Gabriel
Director
The Prospect Company
One Tower Square
Hartford Connecticut 06183

Dear Brian:

Transmitted herewith is the required scope of the Environmental Impact Assessment Report (EIR) for the proposed Travelers/New England Telephone development. This material includes the format of the EIR and a description of the environmental issues to be addressed.

If questions arise concerning the scope, please ask your consultants to contact me or Richard Mertens of our Environmental review staff.

Sincerely,

William D. Whitney
Deputy Assistant Director for
Development and Urban Design

TRAVELERS DEVELOPMENT

BRA Environmental Impact Assessment Scope

Process

Due to the scale and potential impact of the proposed development, the Boston Redevelopment Authority, under its Development Review Procedures, will require a full Environmental Impact Assessment Report (EIA) which will be made available for public and agency review prior to final approval of the project by the Authority. The EIA is to be published in draft and final forms, the Final EIA to respond to comments received on the Draft EIA as well as provide revised or corrected analyses if required. A thirty-day public comment period follows publication of both the Draft and the Final EIAs. The project proponent shall furnish the Authority with sufficient copies of the reports for public and agency distribution.

Format of the EIA

The EIA shall include a copy of the BRA scope of the impact assessment report as well as a copy of the separate Transportation Impacts/Access Plan scope.

The EIA shall include the following sections:

1. Executive Summary: A summary of the Report and its findings, brief and understandable by the lay person, shall be included at the beginning of the report.

2. Project Description: A detailed description of the project, including its history and project background, and a statement of the project objectives and relation to the BRA's downtown planning goals. A discussion of project alternatives that previously have been considered and/or rejected also shall be included.

3. Project Area Description: A description of the environmental surroundings as they exist before the project is commenced, including the physical, economic, and social characteristics in the immediate area of the project, and any unique or special aspects which should be considered.

4. Environmental Impact Analyses: A detailed description of the probable impacts of the project on the environment, including both damage and benefit to the environment arising from the project.

5. Mitigation Measures: A description of all measures during design, construction, or operation which will be utilized to minimize environmental damage or produce beneficial impact.

Background data and special studies undertaken in connection with the impact analyses should be included as appendices.

Graphics and maps included in the text shall be clear and readable and should be integrated with the text for easy reference. To the extent possible, all maps should be at the same orientation and include a north arrow and street names.

Scope of Environmental Issues

The following areas of environmental analyses shall be included in the EIA:

A. Transportation Impacts/Access Plan

(See also the more detailed Vanasse/Hangen Comprehensive Transportation Assessment/Access Plan scope)

This section shall include a description of existing conditions in the project area, including the roadway network, existing circulation and traffic volumes, existing pedestrian volumes, the public transportation system, and parking facilities and usage, and the probable project impacts, as outlined below.

1. Vehicular Traffic

   a. Project vehicular traffic demand and generation (daily and peak-hours) and distribution

   b. Circulation and access impacts on the local and regional street system and local intersections (traffic impact area), including capacity and level-of-service analyses

   c. Modal split and vehicle occupancy analysis

2. Public Transportation

   a. Location and availability of public transportation facilities

   b. Usage and capacity of existing system

   c. Peak-hour demand and capacity analysis

   d. Measures to encourage use of public transportation

3. Pedestrian Circulation

   a. Demand and capacity analysis on project area sidewalks

   b. Connections to public transportation station stops

   c. Effect on pedestrian flows of project parking and servicing entrances and exits

4. Parking

   a. Number of spaces provided indicating public and private allocation

b. Reduction in parking from previous use of site

c. Proposal's impact on demand for parking

d. Parking plan, including layout, access, and size of spaces

e. Evidence of compliance with City of Boston parking freeze requirements

5. Loading

a. Number of docks

b. Location and dimension of docks

c. Size and maneuvering space on-site or in public right-of-way

6. Access, curb cuts, and/or sidewalk changes required.

7. Access Plan

a. Measures to manage parking demand and optimize use of available parking spaces, including:

- o Proposed rate structures(s)
- o Ride-sharing incentives and information dissemination
- o Set-asides for high-occupancy-vehicles: number and location
- o Set-asides for after morning commuter peak (usually 9:30 or 10:00 a.m.)

b. Measures to encourage public transportation use, including:

- o Mass transit information dissemination
- o MBTA pass sales and subsidies
- o Direct station links or pedestrian connections

c. Measures to reduce peaking, including:

- o Encouragement of flexible work hours
- o Restrictions on service and good deliveries

d. Measures to mitigate construction impacts, including:

- o Time and routes of truck movements
- o Storage of materials and equipment
- o Worker parking and commuting plan

e. Monitoring and reporting measures

B. <u>Wind</u>

Information on pedestrian level winds is required for both build and no-build conditions. Particular attention shall be given to public and other areas of pedestrian use (sidewalks, plazas, building entrances, etc.) adjacent to and in the vicinity of the project site. The wind impact analyses shall be conducted for both Phase I of the proposed development and for the full-build (Phase I and Phase II) development. Location of the hot-wire testing points shall be selected in consultation with the BRA.

1. Wind tunnel testing is to be conducted in two stages - Stage I Qualitative Study and Stage II Hot Wire Testing. For Stage I, an erosion study (or equivalent methodology) must be conducted to determine potential problem areas and to identify appropriate placement of sensors for hot wire testing.

2. Wind tunnel testing is to be conducted according to the following criteria:

    a. Results of wind tunnel testing shall be consistently presented in miles per hour (mph).

    b. Velocities shall be measured at a scale equivalent to 6 feet above ground level.

    c. The instrument shall have a frequency response that is flat to 100 hertz and filters out any higher frequency (hot wire testing).

    d. Wind directions from the sixteen compass points shall be evaluated.

3. Hot wire data shall be presented both in tabular form and graphically on a map to indicate velocity changes between build and no-build conditions.

    a. The effective gust velocity can be computed by the formula: average hourly velocity plus 1.5 x root mean square (rms) variations about the average.

    b. Analysis shall be presented as follows:

        o Present data for existing (no-build) and future build scenarios as follows:
          Mean velocity (exceeded 1% of time)
          Effective gust velocity (exceeded 1% of time)

        o Compare mean and effective gust wind speeds on both annual and seasonal basis, by wind direction.

- o Provide a written descriptive analysis of wind environment and impacts for each sensor point including such items as source of winds, direction, seasonal variations, etc., as applicable. Include analysis of suitability of location for various activities (e.g., walking, sitting, eating, etc.) as appropriate.

- o Provide maps of sensor locations with wind speed data, graphically indicating changes in wind speeds.

c. For areas where wind speeds are projected to exceed acceptable levels, measures to reduce wind speeds and mitigate potential adverse impact shall be identified.

C. <u>Shadow</u>

1. A shadow impact analysis shall be undertaken, with particular attention given to plazas, sidewalks, and other public open space areas in the project vicinity.

2. Shadow impact analysis must include net new shadows as well as existing shadows.

3. Shadow analyses must include shadow impacts for build and no-build conditions for the hours 9:00 a.m., 12:00 noon, and 3:00 p.m. conducted for four periods of the year at the vernal equinox, autumnal equinox, winter solstice, and summer solstice.

4. Shadow analyses also are to be conducted at 10:00 a.m., 11:00 a.m., 12:00 noon, 1:00 p.m., and 2:00 p.m. on October 21 and November 21, and must show the incremental effects of the proposed massing on proposed or existing public spaces including major pedestrian areas.

5. The shadow analyses shall be conducted for both Phase I of the proposed development and for the full-build development. These analyses may be included on the same maps but the differences between existing shadows, Phase I, and full-build must be clearly distinguished.

D. <u>Daylight</u>

1. A daylight analysis for build (Phase I and full-build) and no-build conditions should be conducted by measuring the percentage of skydome that is obstructed by the project. Specific technique and graphic methodologies required for determining the percent of obstructed skydome will be provided by the BRA.

E. <u>Excavation/Soil Conditions</u>

1. Written description including amount and method of excavation and any proposals for blasting and/or pile driving.

2. Analysis of sub-soil conditions, potential for ground movement and settlement during excavation, and impact on adjacent buildings and utility lines

F. Air Quality

Prior to initiation of the air quality analyses, consultation with the BRA and the Division of Air Quality Control, Department of Environmental Quality Engineering, to determine the appropriate methodology and analytical technique to be used, receptor locations, assumptions, and other input data shall be required. The air quality analyses shall include the following elements:

1. Impact on local air quality from additional traffic generated by the project, including identification of any location projected to exceed national or Massachusetts air quality standards

2. Estimation of emissions from the parking garage constructed as part of the project

3. Description and location of building/garage air intake and exhaust systems and evaluation of impact on pedestrians

G. Noise

1. Noise impact of the project's mechanical and ventilation (HVAC) systems.

2. Impact on the project components of the incorporation of the Fort Hill fire station into the project development.

H. Utility Systems

1. Estimated water consumption and sewage generation from the project

2. Description of the capacity and adequacy of water and sewer systems and an evaluation of the impacts of the project on these systems

3. Identification of measures to conserve resources, including any provisions for recycling

I. Energy

1. Description of energy requirements of the project and evaluation of project impacts on resources and supply

2. Description of measures to conserve energy usage and consideration of feasibility of including solar energy provisions

J. Historical Landmarks

1. Description of the project site location in proximity to any National or Massachusetts Register site or district or Landmark designated by the Boston Landmarks Commission

2. Identification of Boston Landmarks Commission ratings for existing buildings.

3. Possible effects to the National or Massachusetts Register site or district or a Landmark designated by the Boston Landmarks Commission

K. Design and Aesthetics

1. A description of the relationship of the proposed project to the surrounding environment in terms of massing, building heights, scaling elements, materials, open spaces, land uses, and density, and potential effects of the project. Eye-level perspectives showing the project in the context of the surrounding area, and sketches and diagrams to clarify design issues and massing options should be included, as appropriate.

2. A description of proposed site improvements and amenities, including paving, landscaping, lighting, and street furniture.

3. A description of the design evolution of the project through the design process, including changes in the project design, height, and massing, and the reasoning for such changes.

L. Construction Impacts

1. Description of construction staging areas

2. Availability of construction worker parking

3. Potential dust generation and mitigation measures to control dust emissions

4. Potential noise impact and measures to minimize noise levels

5. Truck traffic and access routes

6. Pedestrian safety

BOSTON
REDEVELOPMENT
AUTHORITY

Raymond L. Flynn
Mayor

Stephen Coyle
Director

One City Hall Square
Boston, MA 02201
(617) 722-4300

August 14, 1986

Mr. Brian K. Gabriel
Director
The Prospect Company
One Tower Square
Hartford, CT 06183

Dear Brian:

As we have discussed on several occasions, the required project review submission materials for the Travelers/New England Telephone development proposal are outlined in the Authority's Development Review Procedures booklet which has been provided to you. This letter is written to supplement those requirements.

Please submit the information items listed below which are more fully explained in the Development Review Procedures booklet for the schematic review:

1. Applicant Information
2. Financial Information
3. Project Area Description
4. Schematic Design Material
5. Environmental Assessment
6. Public Benefits Description
7. List of Regulatory Controls and Permits Required
8. Community Groups List

Your project will require submission of an Environmental Notification Form to the MEPA unit of the Massachusetts Executive Office of Environmental Affairs and may require the preparation of an Environmental Impact Report (EIR) pursuant to the applicable provisions of the Massachusetts Environmental Protection Act.

Notwithstanding the state's requirements, however, the Authority will require an EIR for its own review. In addition, a draft Traffic Impact Study and a draft Transportation Access Plan should accompany the shadow, wind, and sunlight analyses in your Schematic Design review submission materials. We have met with your consultants to discuss the scope of these analyses.

The following materials will be required during the second phase of project review, Design Development Review:

1. Design Development Materials (See Development Review Procedures).

2. Employment Plans.

Respecting the employment plans requirement, please be advised that Mayor Flynn's Executive Order Extending the Boston Residents Job Policy requires that the developers of new private development projects for which Development Impact Project Plans are required submit a Boston Residents Construction Employment Plan. In addition, an agreement between the development entity and the Authority regarding permanent employment will be required.

A final design submission and BRA approval of contract documents will also be required (See Development Review Procedures).

Additional information may be required during the course of our review of the project. Should you or your counsel have any questions concerning these matters, please contact me.

Sincerely,

William D. Whitney
Deputy Assistant Director for
Development and Urban Design

T8/BW4

BOSTON
REDEVELOPMENT
AUTHORITY

Raymond L. Flynn
Mayor

Stephen Coyle
Director

One City Hall Square
Boston, MA 02201
(617) 722-4300

August 25, 1986

Mr. David A. Bohn, P.E.
Vanasse/Hangen
60 Birmingham Parkway
Boston, Massachusetts 02135

Re: Travelers/New England Telephone Development Proposal

Dear Mr. Bohn:

I have consulted with Andy McClurg of the City of Boston Department of Transportation and Richard Mertens of the BRA environmental review staff and ask that the following modifications be made to your proposed scope of services pertaining to the above-referenced project transmitted with your letter of July 31, 1986:

A. Description of Services

° This section should include such additional tasks as may be required to incorporate, by reference, the Transportation Impact Assessment Report (see Attachment A).

° In evaluating "the project's compatibility with several specific roadway improvement projects," the enumerated projects should include, but not be limited to, the proposed relocation of the Northern Avenue Bridge with attendant roadway realignment.

B. Study Area

The study area should be expanded in a southerly direction to include the Dewey Square area as indicated on Attachment B.

C. Definition of Tasks

° General comment: Fully document data sources and identify how data differ from findings in previous studies. Please explain any such changes.

° 2.3: Background traffic should include traffic from major construction projects in the Back Bay and South Boston which would enter the downtown study area.

- 2.4.1: Include the existing Central Artery in these calculations.

- 2.4.2: Discuss displacement impacts on existing on-site parking.

- 2.4.3: Clearly evaluate capacity impacts in this section, particularly during peak hours.

- 2.4.4: A demand/capacity impact analysis for sidewalks adjacent to the site and in the study area should be performed.

- Tasks 3 and 4: It is unclear as to whether the promulgation of specific mitigation measures to lessen the impacts of the proposed project during construction is contemplated. This is required.

Please be advised that the Draft Downtown Interim Planning Overlay District now under review by the Authority Board provides that developers of major new downtown projects would be required to submit Transportation Access Plans which "will identify the impacts of new development on traffic and parking and require mitigation measures to address these impacts." We have provided the developer with a draft of that document.

Regarding the presentation of the findings, it is expected that both the draft and final EIRs for the project will contain all traffic and transportation impact and access material prepared. In addition, the separate, stand-alone document including the Transportation Access Plan and the Traffic Impact Analysis with mitigation measures proposed for both the construction and operating periods of the project is needed.

Please feel free to contact me if questions arise concerning these comments.

Sincerely,

William D. Whitney
Deputy Assistant Director for
Development and Urban Design

cc: Brian K. Gabriel
Andrew McClurg
Richard Mertens
Neil Middleton

T8/BW3

TRAVELERS DEVELOPMENT

BRA Environmental Impact Assessment Scope

Process

Due to the scale and potential impact of the proposed development, the Boston Redevelopment Authority, under its Development Review Procedures, will require a full Environmental Impact Assessment Report (EIA) which will be made available for public and agency review prior to final approval of the project by the Authority. The EIA is to be published in draft and final forms, the Final EIA to respond to comments received on the Draft EIA as well as provide revised or corrected analyses if required. A thirty-day public comment period follows publication of both the Draft and the Final EIAs. The project proponent shall furnish the Authority with sufficient copies of the reports for public and agency distribution.

Format of the EIA

The EIA shall include a copy of the BRA scope of the impact assessment report as well as a copy of the separate Transportation Impacts/Access Plan scope.

The EIA shall include the following sections:

1. Executive Summary: A summary of the Report and its findings, brief and understandable by the lay person, shall be included at the beginning of the report.

2. Project Description: A detailed description of the project, including its history and project background, and a statement of the project objectives and relation to the BRA's downtown planning goals. A discussion of project alternatives that previously have been considered and/or rejected also shall be included.

3. Project Area Description: A description of the environmental surroundings as they exist before the project is commenced, including the physical, economic, and social characteristics in the immediate area of the project, and any unique or special aspects which should be considered.

4. Environmental Impact Analyses: A detailed description of the probable impacts of the project on the environment, including both damage and benefit to the environment arising from the project.

5. Mitigation Measures: A description of all measures during design, construction, or operation which will be utilized to minimize environmental damage or produce beneficial impact.

Background data and special studies undertaken in connection with the impact analyses should be included as appendices.

Graphics and maps included in the text shall be clear and readable and should be integrated with the text for easy reference. To the extent possible, all maps should be at the same orientation and include a north arrow and street names.

Scope of Environmental Issues

The following areas of environmental analyses shall be included in the EIA:

A. Transportation Impacts/Access Plan

(See also the more detailed Vanasse/Hangen Comprehensive Transportation Assessment/Access Plan scope)

This section shall include a description of existing conditions in the project area, including the roadway network, existing circulation and traffic volumes, existing pedestrian volumes, the public transportation system, and parking facilities and usage, and the probable project impacts, as outlined below.

1. Vehicular Traffic

   a. Project vehicular traffic demand and generation (daily and peak-hours) and distribution

   b. Circulation and access impacts on the local and regional street system and local intersections (traffic impact area), including capacity and level-of-service analyses

   c. Modal split and vehicle occupancy analysis

2. Public Transportation

   a. Location and availability of public transportation facilities

   b. Usage and capacity of existing system

   c. Peak-hour demand and capacity analysis

   d. Measures to encourage use of public transportation

3. Pedestrian Circulation

   a. Demand and capacity analysis on project area sidewalks

   b. Connections to public transportation station stops

   c. Effect on pedestrian flows of project parking and servicing entrances and exits

4. Parking

   a. Number of spaces provided indicating public and private allocation

b. Reduction in parking from previous use of site

c. Proposal's impact on demand for parking

d. Parking plan, including layout, access, and size of spaces

e. Evidence of compliance with City of Boston parking freeze requirements

5. Loading

a. Number of docks

b. Location and dimension of docks

c. Size and maneuvering space on-site or in public right-of-way

6. Access, curb cuts, and/or sidewalk changes required.

7. Access Plan

a. Measures to manage parking demand and optimize use of available parking spaces, including:

- o Proposed rate structures(s)
- o Ride-sharing incentives and information dissemination
- o Set-asides for high-occupancy-vehicles: number and location
- o Set-asides for after morning commuter peak (usually 9:30 or 10:00 a.m.)

b. Measures to encourage public transportation use, including:

- o Mass transit information dissemination
- o MBTA pass sales and subsidies
- o Direct station links or pedestrian connections

c. Measures to reduce peaking, including:

- o Encouragement of flexible work hours
- o Restrictions on service and good deliveries

d. Measures to mitigate construction impacts, including:

- o Time and routes of truck movements
- o Storage of materials and equipment
- o Worker parking and commuting plan

e. Monitoring and reporting measures

B. <u>Wind</u>

Information on pedestrian level winds is required for both build and no-build conditions. Particular attention shall be given to public and other areas of pedestrian use (sidewalks, plazas, building entrances, etc.) adjacent to and in the vicinity of the project site. The wind impact analyses shall be conducted for both Phase I of the proposed development and for the full-build (Phase I and Phase II) development. Location of the hot-wire testing points shall be selected in consultation with the BRA.

1. Wind tunnel testing is to be conducted in two stages - Stage I Qualitative Study and Stage II Hot Wire Testing. For Stage I, an erosion study (or equivalent methodology) must be conducted to determine potential problem areas and to identify appropriate placement of sensors for hot wire testing.

2. Wind tunnel testing is to be conducted according to the following criteria:

   a. Results of wind tunnel testing shall be consistently presented in miles per hour (mph).

   b. Velocities shall be measured at a scale equivalent to 6 feet above ground level.

   c. The instrument shall have a frequency response that is flat to 100 hertz and filters out any higher frequency (hot wire testing).

   d. Wind directions from the sixteen compass points shall be evaluated.

3. Hot wire data shall be presented both in tabular form and graphically on a map to indicate velocity changes between build and no-build conditions.

   a. The effective gust velocity can be computed by the formula: average hourly velocity plus 1.5 x root mean square (rms) variations about the average.

   b. Analysis shall be presented as follows:

      o Present data for existing (no-build) and future build scenarios as follows:
        Mean velocity (exceeded 1% of time)
        Effective gust velocity (exceeded 1% of time)

      o Compare mean and effective gust wind speeds on both annual and seasonal basis, by wind direction.

- o Provide a written descriptive analysis of wind environment and impacts for each sensor point including such items as source of winds, direction, seasonal variations, etc., as applicable. Include analysis of suitability of location for various activities (e.g., walking, sitting, eating, etc.) as appropriate.

- o Provide maps of sensor locations with wind speed data, graphically indicating changes in wind speeds.

c. For areas where wind speeds are projected to exceed acceptable levels, measures to reduce wind speeds and mitigate potential adverse impact shall be identified.

C. <u>Shadow</u>

1. A shadow impact analysis shall be undertaken, with particular attention given to plazas, sidewalks, and other public open space areas in the project vicinity.

2. Shadow impact analysis must include net new shadows as well as existing shadows.

3. Shadow analyses must include shadow impacts for build and no-build conditions for the hours 9:00 a.m., 12:00 noon, and 3:00 p.m. conducted for four periods of the year at the vernal equinox, autumnal equinox, winter solstice, and summer solstice.

4. Shadow analyses also are to be conducted at 10:00 a.m., 11:00 a.m., 12:00 noon, 1:00 p.m., and 2:00 p.m. on October 21 and November 21, and must show the incremental effects of the proposed massing on proposed or existing public spaces including major pedestrian areas.

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1. A daylight analysis for build (Phase I and full-build) and no-build conditions should be conducted by measuring the percentage of skydome that is obstructed by the project. Specific technique and graphic methodologies required for determining the percent of obstructed skydome will be provided by the BRA.

E. <u>Excavation/Soil Conditions</u>

1. Written description including amount and method of excavation and any proposals for blasting and/or pile driving.

2. Analysis of sub-soil conditions, potential for ground movement and settlement during excavation, and impact on adjacent buildings and utility lines

F. Air Quality

Prior to initiation of the air quality analyses, consultation with the BRA and the Division of Air Quality Control, Department of Environmental Quality Engineering, to determine the appropriate methodology and analytical technique to be used, receptor locations, assumptions, and other input data shall be required. The air quality analyses shall include the following elements:

1. Impact on local air quality from additional traffic generated by the project, including identification of any location projected to exceed national or Massachusetts air quality standards

2. Estimation of emissions from the parking garage constructed as part of the project

3. Description and location of building/garage air intake and exhaust systems and evaluation of impact on pedestrians

G. Noise

1. Noise impact of the project's mechanical and ventilation (HVAC) systems.

2. Impact on the project components of the incorporation of the Fort Hill fire station into the project development.

H. Utility Systems

1. Estimated water consumption and sewage generation from the project

2. Description of the capacity and adequacy of water and sewer systems and an evaluation of the impacts of the project on these systems

3. Identification of measures to conserve resources, including any provisions for recycling

I. Energy

1. Description of energy requirements of the project and evaluation of project impacts on resources and supply

2. Description of measures to conserve energy usage and consideration of feasibility of including solar energy provisions

J. Historical Landmarks

1. Description of the project site location in proximity to any National or Massachusetts Register site or district or Landmark designated by the Boston Landmarks Commission

2. Identification of Boston Landmarks Commission ratings for existing buildings.

3. Possible effects to the National or Massachusetts Register site or district or a Landmark designated by the Boston Landmarks Commission

K. Design and Aesthetics

1. A description of the relationship of the proposed project to the surrounding environment in terms of massing, building heights, scaling elements, materials, open spaces, land uses, and density, and potential effects of the project. Eye-level perspectives showing the project in the context of the surrounding area, and sketches and diagrams to clarify design issues and massing options should be included, as appropriate.

2. A description of proposed site improvements and amenities, including paving, landscaping, lighting, and street furniture.

3. A description of the design evolution of the project through the design process, including changes in the project design, height, and massing, and the reasoning for such changes.

L. Construction Impacts

1. Description of construction staging areas

2. Availability of construction worker parking

3. Potential dust generation and mitigation measures to control dust emissions

4. Potential noise impact and measures to minimize noise levels

5. Truck traffic and access routes

6. Pedestrian safety

Vanasse Hangen
60 Birmingham Parkway
Boston Massachusetts 02135
617 783 7000

Consulting Engineers
& Planners

July 31, 1986

Ref: 1602

Mr. William D. Whitney
Deputy Assistant Director for Development Policy
Boston Redevelopment Authority
One City Hall Square
Boston, MA 02201

Re: Prospect/New England Telephone Development
High Street

Dear Mr. Whitney:

Enclosed for your review is a draft scope of services for the preparation of a Comprehensive Transportation Assessment/Access Plan for the subject project.

This draft scope represents our understanding of the environmental issues related to transportation that need to be addressed, based on the scoping meeting held at City Hall on July 30, 1986.

Your comments on the scope would be appreciated. One major issue still to be resolved is that of defining a study area for the traffic impact analysis. For review purposes, we have inserted the same study area used in the International Place EIR prepared for MEPA. We recognize that it will be necessary to review with City staff the actual limits of the study area for this effort.

We look forward to meeting again to discuss our proposed scope. I will be on vacation the week of August 4-9 so if you have any questions, please contact Ray Niedowski (at 783-7000) who will be our Senior Project Manager for this effort.

Very truly yours,

VANASSE/HANGEN

David A. Bohn

David A. Bohn, P.E.
Associate

DAB/dms

cc: Richard Merte[illegible], BRA
Andy McClurg, ETI
Peggy Briggs, [illegible]
Neil Middleton, BRA
WJR, RSN

1602/786/p11

VH

PROPOSED SCOPE OF SERVICES
COMPREHENSIVE TRANSPORTATION ASSESSMENT/ACCESS PLAN
PROSPECT COMPANY/NEW ENGLAND
TELEPHONE CO. DEVELOPMENT

A. DESCRIPTION OF SERVICES

Vanasse/Hangen will perform the necessary transportation planning and engineering tasks involved in the preparation of a Comprehensive Transportation Assessment of the proposed Prospect Company/New England Telephone Co. Development, including the following:

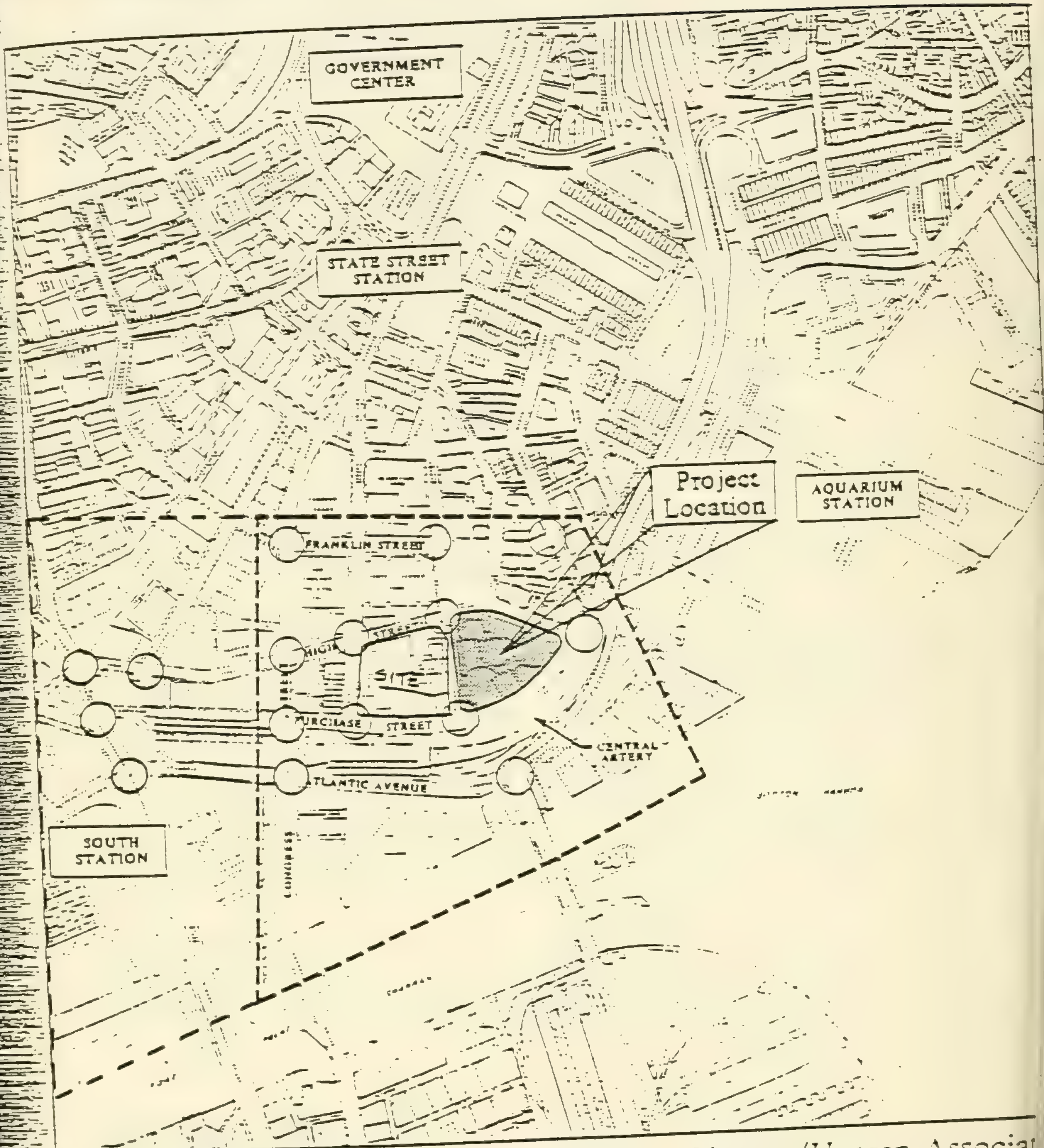
- A definition of existing traffic, parking, pedestrian and transit conditions in the study area.
- An evaluation of the project's short-term traffic impacts related to construction activity.
- An evaluation of long-term impacts on traffic, parking, public transportation and pedestrians.
- An evaluation of the project's compatibility with several specific roadway improvement projects including:
  - The proposed relocation of the High Street off-ramp to Purchase Street prior to construction of the Depressed Central Artery.
  - The Dewey Square Transportation Systems Management Project
  - The proposed plan to construct an off-ramp from the Depressed Central Artery to Purchase Street.
- Consideration of loading/service facilities.
- Identification of appropriate mitigation measures to reduce project impacts.

The work effort has been designed to build upon previous and on-going transportation studies being conducted in the area. It will take into consideration other significant projects which will be completed in the same time frame and which will exert an influence on areawide travel demands.

B. STUDY AREA

The study will be limited to the area bounded by Congress Street, Atlantic Avenue, Franklin Street, and the Fort Point Channel as indicated in Figure 1. Specific intersection locations to be analyzed are also indicated in the figure.

Figure 4.1 - Transportation Study Area



Vanasse/Hangen Associat
Boston, M

International
Place
at Fort Hill

VH

C. DEFINITION OF TASKS

Task 1 - Data Inventory/Environmental Baseline Conditions

Vanasse/Hangen will compile data on supply and usage characteristics of the transportation system within the study area. New data to be collected as part of this effort will be limited to several intersections where traffic counting is necessary to expand upon available data. Several sources of traffic data exist including the International Place EIR, the Dewey Square TSM Study, the Rowes & Fosters Wharf EIR, and the Fan Pier/Pier 4 EIR. The approach taken to develop base traffic conditions will be similar to that taken in the recent Environmental Assessment for 125 Summer Street. Based on data gathered from all sources, a preliminary base traffic volume network will be developed to represent existing conditions. Vanasse/Hangen will meet with BRA and BTD staff prior to finalization of the base condition traffic volumes for the purpose of reviewing the data and obtaining input.

Data will also be gathered from the two major tenants of the proposed building: New England Telephone and the Travelers Insurance Company. Such information will include shift patterns, mode of arrival, parking patterns, and employee residence location.

Parking characteristics in the study area in proximity to the site will be defined. In addition, the MBTA will be contacted to ascertain the latest data available on transit usage levels and improvement plans for commuter rail, rapid transit and local/express bus services.
All other baseline transportation data will be derived from previously compiled information and reports.

Task 2 - Evaluation of Long-Term Impacts following completion of the project)

2.1 Alternatives to be Analyzed

Two development options will be examined: 1) all-office use of the site, and 2) a combination office/hotel project.

The peak period traffic/transit impacts will be estimated for each alternative. The option having the largest effect on the environment will be determined and carried through the remainder of the analysis.

2.1 Conditions to be Analyzed

The following time frames will be analyzed:

- o No Build (with only background projects anticipated to be completed included) - 1994.

VH

- o Full Build with addition of project-related impacts on existing street system - 1994.

- o Full Buildwith addition of project-related impacts on modified street system, assuming High Street off-ramp is relocated to Purchase Street - 1994.

2.3 Background Development and Transportation Projects

Building construction projects to be included in the No Build evaluation are the specific on-going projects along the Bedford St./Essex Street corridor such as 125 Summer Street, as well as projects on Federal Street, International Place, South Station Intermodal Facility, Fan Pier/Pier 4, and Rowes Wharf. The assumptions on which specific projects are to be included in the background volumes will be reviewed with BRA and BTD staff prior to actual analysis.

Transportation projects which will be considered include continuing improvements to the MBTA system and the potential Dewey Square TSM improvements. The impacts of the implementation of the Dewey Square TSM Alternatives A and B on the streets in immediate proximity to the site will be considered. Additionally, the proposed plan to construct an off-ramp from the Depressed Central Artery to Purchase Street will be evaluated as it relates to the project site.

2.4 Evaluation of Transportation Impacts

New trips expected to be created by the proposed development will be added to demands currently carried by the existing transportation infrastructure. AM and PM peak hours and daily figures will be developed and analyzed. AM modes will be considered. Impact identifications will be carried out by completing the following tasks:

1. Traffic Impacts - Volume/capacity (v/c), Available Reserve Capacity (ARC), and Level of Service (LOS) calculations at intersections identified in the study area figure.

2. Parking Impacts - Increased parking demand will be compared with existing and projected available supply to identify deficiencies. The analysis will discuss long term vs. short term parking needs and provisions for high occupancy vehicles (HOVs)

3. Public Transportation - Increased ridership and its impacts on the MBTA's rapid transit, commuter rail and local/express bus services will be identified. The potential people-mover proposed by developers of the World Trade Center will also be briefly described in terms of project compatibility.

4. Pedestrian Impacts - An evaluation of pedestrian conditions on sidewalks adjacent to the site and in the study area will be conducted. Pedestrian pathways and linkages to other area attractions and MBTA stations will be identified. Special attention will be given to the existing pedestrian bridge over the Central Artery and the potential for making modifications to it.

5. Loading/Service/On-site Circulation - The proposed loading and service facilities will be defined and evaluated and their functionality analyzed. Truck/service deliveries to the site will also be estimated and on-site circulation patterns will be described.

6. Taxi - Taxi services to the site will be evaluated.

Task 3 - Evaluation of Short-Term Impacts (construction period)

The transportation assessment will evaluate the impacts of the following:

1. Mode of arrival for construction worker trips.

2. Parking for construction workers and construction materials deliveries.

3. Numbers, times and routes of truck movements and construction activities. Where possible, these activities will be coordinated with other on-going projects.

4. Temporary storage of construction equipment and materials.

5. The need for street closures or partial closures will be defined.

Task 4 - Mitigation Measures/Development of an Access Plan

Mitigation measures which would lessen the impacts of the proposed project will be identified. The resultant effect of these measures will be determined through application of either analysis techniques identified under Tasks 2 and 3 or through appropriate qualitative review.

Specific mitigation measures to be considered include:

- Roadway/traffic operations improvements
- Transit pass subsidies
- Differential parking fees

- Pedestrian connections/improvements
- Ridesharing/vanpooling
- Other alternatives to be identified
- Monitoring and enforcement measures

Specific committments made by the developer will be identified. Further, if one of the two proposed development plans for the site require additional or different mitigation, these specific needs will be identified.

The results of this four-task effort will be incorporated into the Environmental Assessment Report which will define work performed during the study and documentation of the study process, procedures and findings. A separate, stand-alone document entitled Transportation Access Plan will also be prepared for use by the Boston Transportation Department. This document will contain much of the same material as the BRA's Environmental Assessment Report, particularly the impact analysis and mitigation sections, but will be formatted specifically according to BTD requirements.

BOSTON
REDEVELOPMENT
AUTHORITY

Raymond L. Flynn
Mayor

Stephen Coyle
Director

One City Hall Square
Boston, MA 02201
(617) 722-4300

February 12, 1987

Mr. Brian K. Gabriel, Director
The Prospect Company
One Tower Square
Hartford, Connecticut 06183

Dear Mr. Gabriel:

Re: 125 High Street Draft Environmental Impact Assessment Report

The Boston Redevelopment Authority staff has reviewed the Draft Environmental Impact Assessment report which you have submitted for the 125 High Street development project in downtown Boston's financial district. In accordance with the Authority's environmental review procedures, this document also has been made available for public and agency review. Our comments on the report are detailed below, and comments received by the Authority during the public review period are attached. The Final Environmental Impact Assessment should respond to these comments and should provide the additional or corrected analyses as indicated.

General/Format

In general, the DEIA has presented a comprehensive analysis of the anticipated impacts of the development of 125 High Street. However, a number of areas of the report require clarification of the information presented or additional analysis that was not included in the draft document. The Final EIA should include all the information and analyses of the Draft EIA, revised or expanded in response to the several comments of the BRA and other reviewers. In addition, the Final report should contain a copy of this letter and copies of all comment letters which have been received during the public comment period. Issues and questions raised in these comments should be addressed either separately or within the body of the report, as appropriate, and with proper references.

6.1 Transportation

Traffic

On page 6.1-10 it is stated that the 125 High Street network is consistent with the 125 Summer Street network. However, a comparison of the existing traffic volumes for each project indicates that for some intersections common to both (e.g.: Congress/High, Congress/Atlantic) volumes are significantly different. This discrepancy should be resolved in the FEIA.

The most serious traffic impact of the project is likely to be at the intersection of Congress and Purchase Streets, where the level-of-service is projected to be at "F" in 1994, with a volume/capacity ratio of 1.25, in the No-Build scenario (P.M. peak hour). The volume that the 125 High Street project would add represents a significant deterioration of a projected unacceptable situation. Although roadway improvements are suggested for this (and other congested) intersections, implementation is dependent on others. The Final EIA should discuss the commitment to implement the suggested improvements.

The Massachusetts Department of Public Works (I-90/I-93 Project) has identified a number of potential conflicts with respect to the use and availability of Purchase Street, both during the construction period for the depression of the Central Artery and during long-term operation. The Department has recommended the coordination of design requirements to arrive at mutually-acceptable accommodations for both projects. The Final EIA should describe the means by which these issues are being addressed.

During the A.M. peak hour, some 3,100 vehicles would be entering Purchase Street at Oliver Street, of which 645 vehicles (or 10 per minute) would enter the garage (based on Fig. 6.1-11). In the evening peak hour, some 2,200 vehicles would be travelling on Purchase Street while 584 vehicles would be exiting the garage (Fig. 6.1-12). The Final EIA should evaluate the impact of the garage traffic (entering and exiting) on Purchase Street traffic flow and on the Purchase/Oliver Streets intersection, both during the A.M. and P.M. peak hours. Included in the analyses should be the effect of morning queuing at the garage entrance on Purchase/Oliver level-of-service. Moreover, the impact on accessibility to and from the fire station also should be examined in the Final EIA.

A new (and presumably more accurate) methodology has been used for the intersectional level-of-service (Special Report 209, Transportation Research Board). The Final EIA should indicate whether the traffic analyses conducted by this methodology accounts for delays resulting from pedestrian traffic or conflicts at the intersections analyzed. Heavy volumes of pedestrians are projected in the direction to and from South Station (from this and other nearby projects) and Dewey Square itself experiences considerable pedestrian traffic.

The Central Artery Impact discussion (pg. 6.1-52) is inadequate. More detail analysis is needed to show the impact on Central Artery traffic, level of service, congestion, etc. of the additional traffic generated by the 125 High Street project, including capacity impacts on ramp merges and weaves and effects on adjacent surface intersections (e.g., Atlantic/Northern Ave.).

The discussion of the Dewey Square TSM Alternative B (pg. 6.1-57) should indicate the effect on LOS levels with implementation of this alternative, particularly the reversal of High Street, on the affected intersections.

In Table 6.1-27, should not the "15" under B (Vehicle Trips: A.M. in (goal)) be "215?"

The differences in volumes and V/C ratios between the 125 High Street report and the Fan Pier/Pier 4 FEIR are explained (pp. 6.1-90, 91). The Final EIA should evaluate the effect of the use of different analysis techniques on the accuracy of the future predictions (i.e., which study is the more accurate?). In addition, the Fan Pier/Pier 4 development program (Table 6.1-16) and vehicle trip generation numbers (Appendix A) are substantially different from the corresponding information in the Fan Pier/ Pier 4 FEIR. This discrepancy should be resolved in the FEIR.

Transit

The data given in Tables 6.1-2 and 6.1-3 on rapid transit capacity, headways, ridership, etc. are, in some cases, significantly different from the same data presented in the 125 Summer Street EIR. This difference should be explained (it is assumed that the ridership differences are due to use of a V/H survey rather than MBTA data).

The rapid transit impact discussion (pg. 6.1-62) should also include an analysis of the impact on the Red Line at South Station from the additional trips (background and project) which would use the Red Line to access the Green Line at Park Street.

Parking

Although the Parking in Central Boston report did state that only 16.7% of the trips generated by the Travelers Building arrive by auto (pg. C-5), this percentage was based on a 1980 Downtown Crossing survey which presumably included non-work trips as well. A later (1982) survey of employees conducted by the City of Boston indicated a significantly higher (42.9% auto use (pg. B-5). Also, the NET survey (Appendix B of the DEIA) shows only a 66%, not 78%, use of public transportation. Further justification of the use of the 30%/70% auto/transit mode split, therefore, will be required, in the light of the above data (pg. 6.1-24).

The Boston Fire Department, in their comment letter, has indicated that a minimum of 30 parking spaces will be required for fire department personnel. The DEIA states that 25 spaces would be reserved for the department. The Final EIA should present a resolution of this parking issue.

The parking analysis (pg. 6.1-70) apparently considers the 125 public spaces as long-term spaces. Should not these spaces be considered as short-term spaces, especially since it is noted in the Parking Supply Management section (pg. 6.1-79) that restrictions will be placed on the use of these spaces to promote short-term use? Thus the long-term (employee) deficit would be 320 spaces rather than 195 spaces and the short-term deficit 140 spaces, for a total deficit of 460 spaces (as noted). The City of Boston (Traffic and Parking) has expressed concern that a mix of both long- and short-term on-site parking be provided.

Pedestrian Analysis

The pedestrian LOS analysis should be included, at least in the appendix.

The Final EIA should briefly summarize the methodology used to determine pedestrian level-of-service. Does this methodology include the effects of driveways and street intersections? If not, what would be the effect?

6-2 Wind

The quantitative (hot-wire) wind impact analysis was based on a previous design for the 20-story office building. The current design is a building that is somewhat longer along Oliver Street. The Final EIA should indicate the extent of any change in wind impact, particularly in the vicinity of Oliver Street, due to the redesign of the office building.

The Wind section of the EIA does not describe the wind standards used by the BRA to evaluate the acceptability of pedestrian level winds in the vicinity of the project. These safety/comfort criteria should be included in the Final EIA together with an analysis as to whether the project meets these standards and an evaluation of the projects' impact on various forms of pedestrian activity.

The erosion study (pg. 6.2-5) indicated that sealing some of the openings in the arcade at the corner of Pearl and High Streets would be effective in reducing high flows through the arcade. The Final EIA should indicate whether this design change has been made and whether it was analyzed in the hot-wire study.

Although there seems to be good agreement between the 125 High Street wind study and the Peterka and Cermak study of International Place for locations close to the International Place project, in most instances P&C's results are higher than those for 125 High Street, in some cases substantially higher. What is the explanation for this?

With respect to seasonal variation, the report indicates (pg. 6.2-20) that winter wind speeds are close to annual speeds. However, most other wind studies in Boston have indicated winter winds to be approximately 10% greater than the annual speeds. The Final EIA should give an explanation of this difference (the other seasons compare favorably).

The results of the wind study (Table 6.2-1) show that with the 30-story building alone there would be two violations of the BRA standard (stations 8 and 13) and with full development one violation (Station 9). Therefore mitigation measures will be required (since the project is responsible for thes exceedances, which do not exist without the project). Both Stations 8 and 9 are critical locations since they are entrances to 125 High Street and International Place respectively. The Final EIA must propose measures to mitigate these excessive winds.

On Table 6.2-3 the last two columns need to be labeled.

In Appendix B-1 the photographs of the sand scour patterns are very p reproduced and impossible to read. Clearer photographs are required f Final EIA.

6.3 Shadow

The winter description of noontime and mid-afternoon shadow effects is reversed (pg. 6.3-5).

The statement on pg. 6.3-6 (para. 3) that the project would have no impact on the Custom House District is incorrect (see the following paragraph). In addition, the summary should note also the spring/fall impact on Post Office Square Park.

6.6 Air Quality

The air quality analysis indicates a potential violation of National and State standards at the Congress and Purchase Streets intersection, which could be minimally exacerbated by the project. This violation is based on the assumptions used in the analysis, which the EIA indicates would not occur were different assumptions used. Nonetheless, the values would be sufficiently close to the standards to cause some concern and the need to explore further mitigation measures. Moreover, Table C.5 in the Appendix shows that a vehicular speed of 20 mph was used to determine composite CO emission rates, but Worksheet 1 indicates a speed of 17 mph was used in the analysis. This discrepancy should be explained in the Final EIA, as well as the effect (if any) on the resulting analysis of CO concentrations.

6.8 Utility Systems

The discussion of the sewer system does not adequately describe the existing system bordering the site nor does it indicate the adequacy of the existing system to handle loads from the project (as well as other existing/proposed (e.g., International Place) projects). No analysis has been included to determine the project impact. The Final EIA should provide this impact assessment.

The DEIA fails to mention the new 15" storm drain in Oliver Street built by the proponents of International Place, which presents the opportunity for the extension of sewer separation to the 125 High Street site. More detailed study of the potential for the separation of storm and sanitary flows should be included in the Final EIA.

The discussion regarding water supply impacts also is inadequate and does not respond to the Scope requirements. There is no discussion of the water service system serving the project site, of its adequacy, and of the project's impact on the capacity of the system to serve the project (as well as other existing and proposed projects in the area). Mitigation measures to reduce water demand also should be described. In addition, the total water consumption requirements, including cooling water, should be given in the FEIA.

6.10 Historic Landmarks

The Boston Landmarks ratings for the existing buildings on the site should be included, as required in the EIA scope (pp. 6.104, 2).

Both the Boston Landmarks Commission and the Boston Preservation Alliance (BPA) have expressed concern about the potential impact of the project on the historic Richardson Block on Pearl Street. The BPA also commented on the historic compatibility of the pedestrian areas surrounding the site. The Final EIA should respond to both of these issues.

The technical corrections included in the Boston Landmarks letter should be incorporated into the Final report.

6.12 Construction Impacts

Air quality impacts of the demolition phase were not discussed in the air quality section of the EIA (pg. 6.12-2).

Also, this section does not discuss construction staging areas or pedestrian safety during construction, as required by the Scope. These items should be added to the Final EIA.

As you are aware, the approval of this project is contingent upon the submission of a satisfactory Final EIA for public review, as well as a commitment to mitigation measures the Authority deems necessary to minimize adverse environmental effects identified in this environmental review process.

I thank you for your cooperation and look forward to the receipt of the Final document.

Sincerely,

William D. Whitney
Deputy Director for
Development and Urban Design

4.0 PROJECT DESCRIPTION

4.0 PROJECT DESCRIPTION

4.1 Location

The project is located in Boston's Financial District at Fort Hill Square. The site encompasses an entire city block of about 2.5 acres, and is bounded by High Street to the north, Purchase Street to the south, Oliver Street to the east, and Pearl Street to the west. The Central Artery is just to the southeast. Neighboring developments include International Place, 260 and 265 Franklin Street, Post Office Square Park and Garage, 101, 140, and 150 Federal Street, and Rowes Wharf across the Expressway. Figure 4-1 depicts the area plan.

4.2 Existing Conditions

The site contains approximately 108,700 square feet (SF) of land. Two major existing structures are on the site: the 16-story Travelers Building containing approximately 358,000 SF of floor space, and a two-story City of Boston fire station containing about 19,000 SF of floor space. There are three vacant connected four- to six-story brick buildings fronting on Oliver and Purchase Streets containing a total of about 43,000 SF of floor space (Figure 4-2 depicts a map of existing conditions). A small, approximately 1,400 SF, City-owned vacant parcel occupies the northeast corner of the site.

Existing open space is limited to parking areas and landscaping outside the Travelers Building. Large brick planters ranging from one foot to two feet in height contain trees, shrubs, and various flowers. There are no benches, but the lunch crowd and passersby sit on the edge of the planters during warm weather.

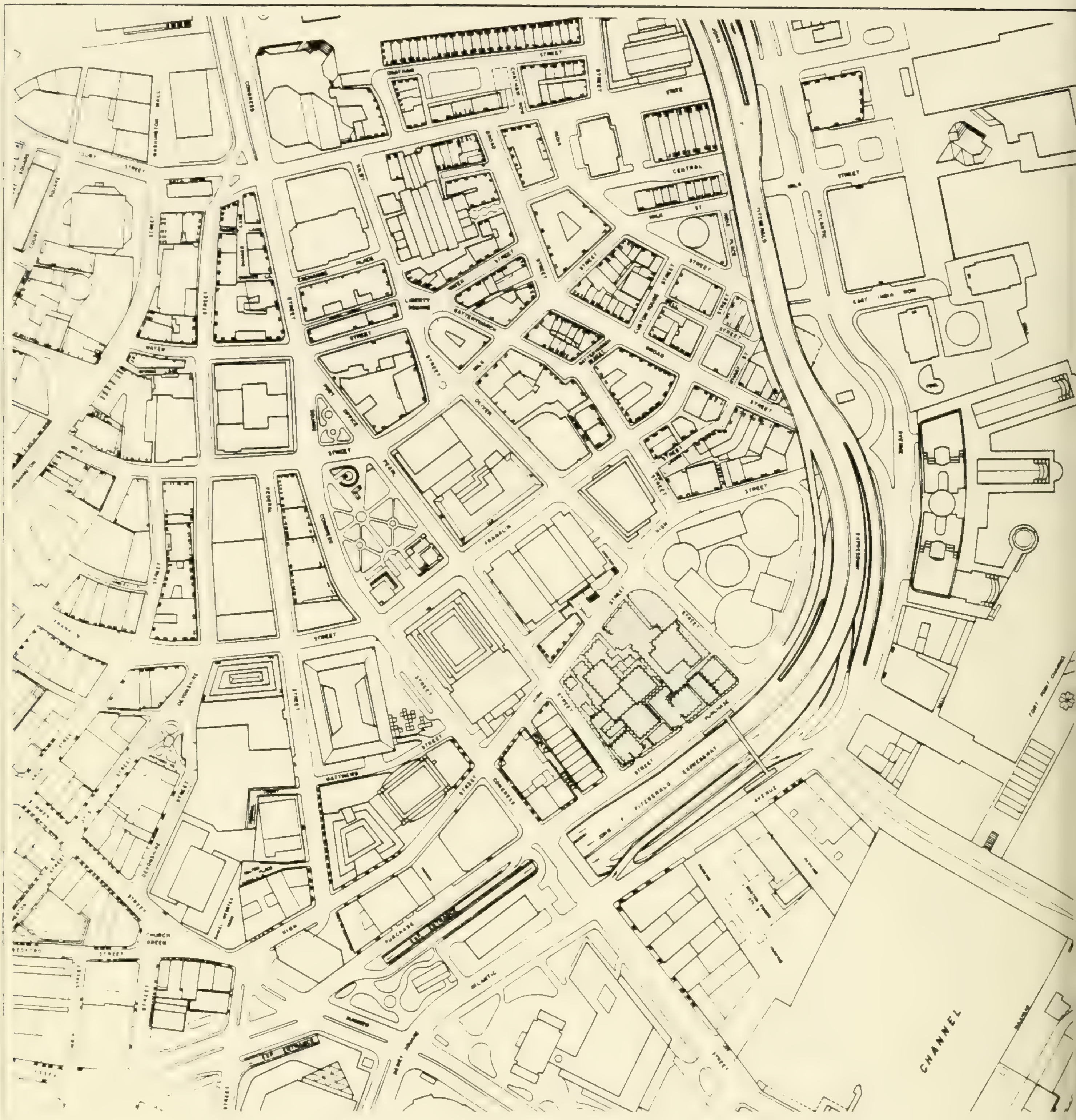


FIGURE 4-1 AREA PLAN

ONE TWENTY FIVE HIGH STREET

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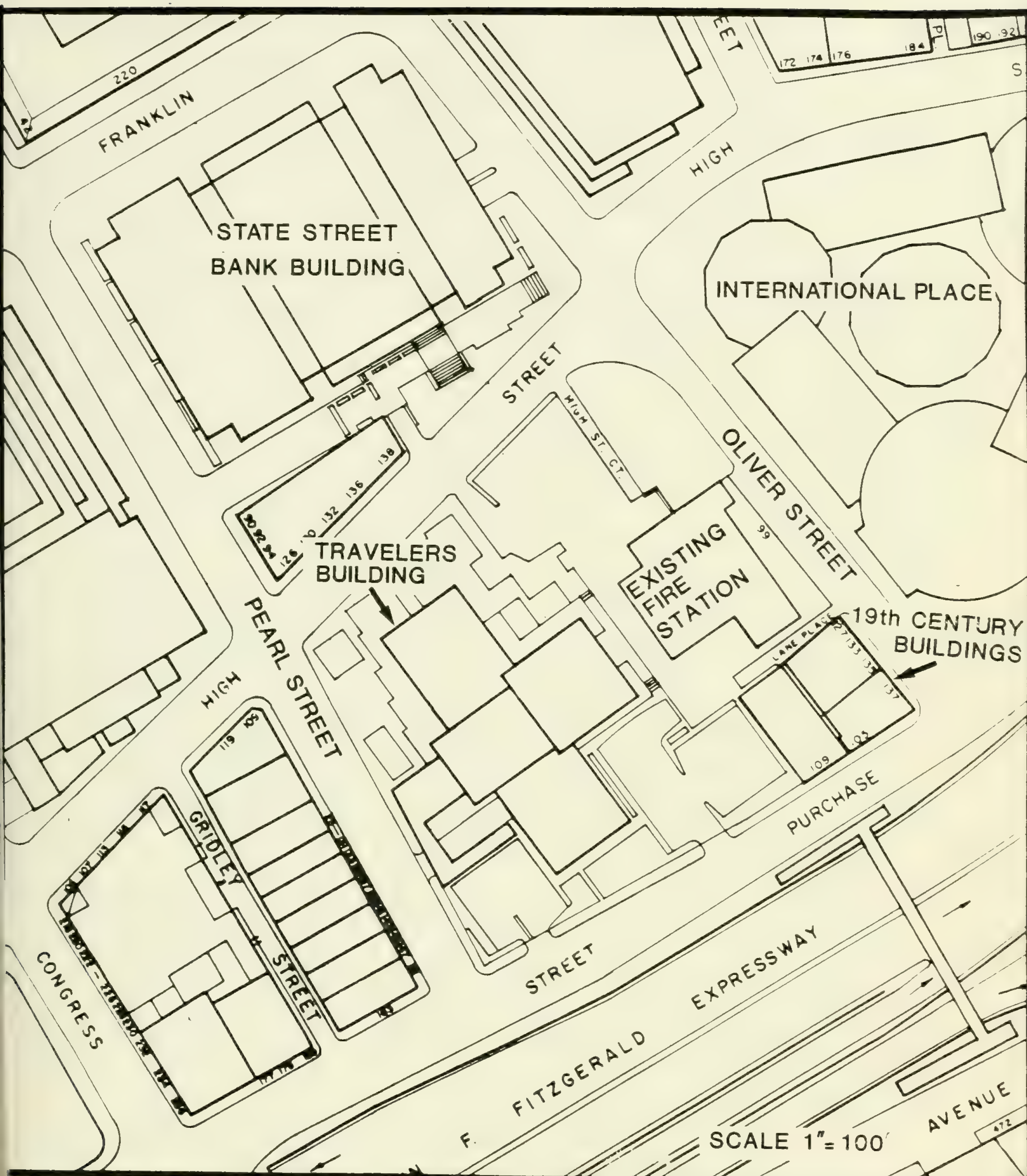

FIGURE 4-2 ONE TWENTY FIVE HIGH STREET SITE - EXISTING CONDITIONS

The site and general vicinity are part of the City's financial district. The area has been undergoing redevelopment, with several significant high rise buildings recently constructed or under construction. These are interspersed with older buildings, some of which have been, or are being restored.

The next group of figures (Figures 4-3 through 4-10) depict photographs of the site showing the existing Travelers Building and nearby buildings.

- View A is looking along High Street. The Travelers Building is in full view, with a portion of International Place shown on the left side of the photograph. The Keystone Building is seen behind the Travelers Building.

- View B is looking down Pearl Street towards its intersection with High Street. The Travelers Building is shown with its entrance on Pearl Street.

- View C is looking along High Street towards its intersection with Pearl Street. A portion of the Travelers Building is shown with the International Place tower (under construction) behind it.

- View D is looking at the Travelers Building from the plaza in front of the Federal Reserve Bank Building. A portion of the New England Telephone Building and State Street Bank are seen on the left side and International Place is seen on the right side.

- View E is looking from across Fort Point Channel. The Travelers Building is in the middle foreground, with the State Street Bank building behind it.

FIGURE 4-3 KEY MAP - VIEWS OF EXISTING SITE CONDITIONS

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FIGURE 4-4 EXISTING CONDITIONS - VIEW A

FIGURE 4-5 EXISTING CONDITIONS - VIEW B

FIGURE 4-6 EXISTING CONDITIONS - VIEW C

FIGURE 4-7 EXISTING CONDITIONS - VIEW D

FIGURE 4-8 EXISTING CONDITIONS - VIEW E

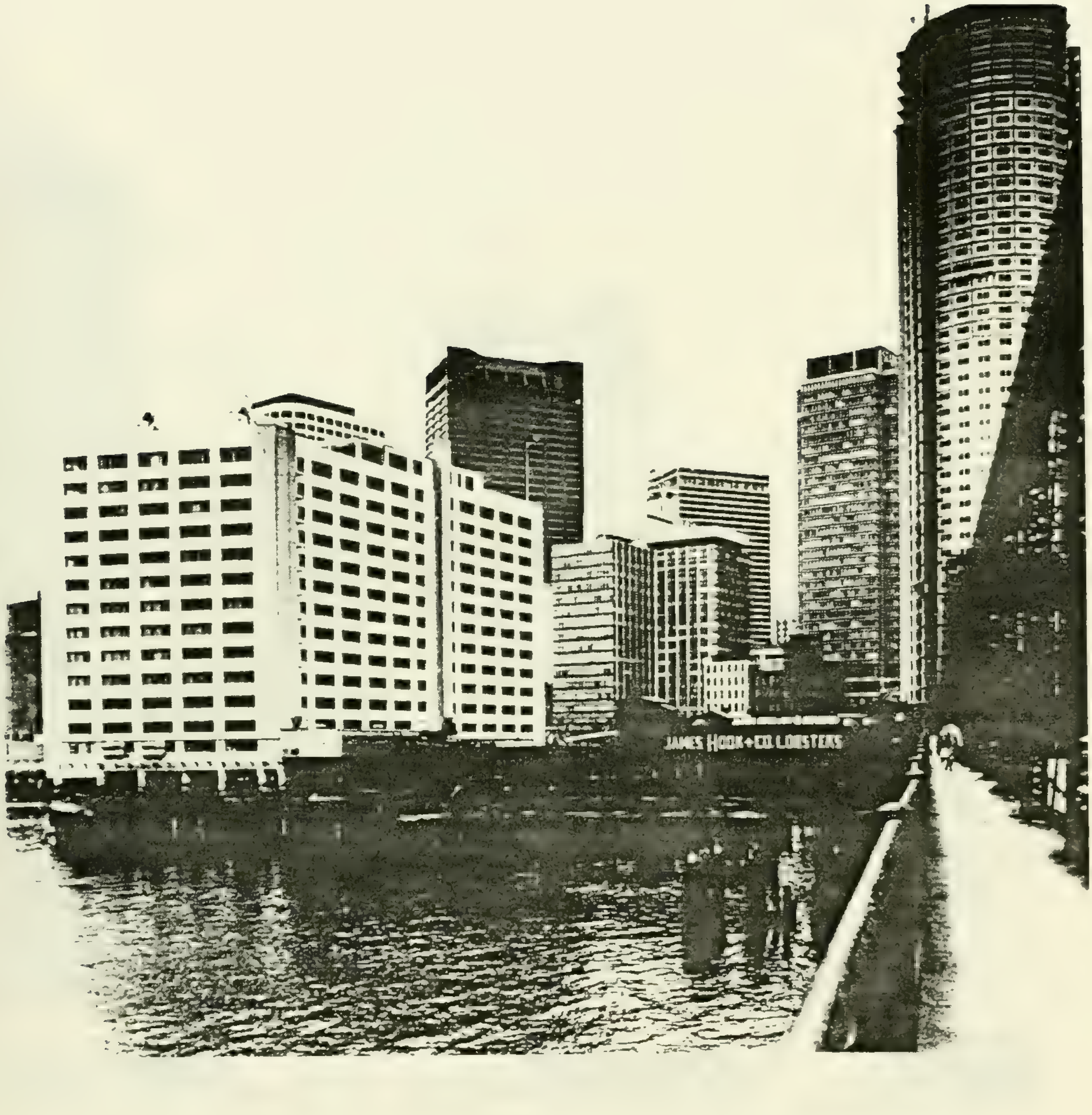

FIGURE 4-9 EXISTING CONDITIONS - VIEW F

FIGURE 4-10 EXISTING CONDITIONS - VIEW G

- View F is taken from the Northern Avenue Bridge across Fort Point Channel showing the Travelers Building in the middle with International Place and State Street Bank on the right.

- View G is another view from Atlantic Avenue and overlooking the Central Artery. In this photograph, the 19th Century buildings are in view just in front of and to the right of the Travelers Building. State Street Bank is in the far right and Bank of Boston is in the background while Keystone Building is shown on the left.

4.3 Proposed New Construction

Proposed new construction will consist of several components (Figure 4-11). The two major structures will be a 30-story office/retail building that will be no more than 400 feet in height and a 21-story building rising to no more than 300 feet in height. The 30-story building will be built on the western side of the site (the existing Travelers Building will be razed). The 21-story building will be located at the northeast corner of the site (the existing fire station will be demolished). A new fire station will be built about mid-block on the site fronting on Purchase Street to replace the existing facility which will be razed to make way for the 21-story building. The three 19th century buildings at the corner of Purchase and Oliver Streets will be retained for office/retail use and a City of Boston ambulance facility. Their exterior facades will be restored to their original appearances and the interiors will be fully renovated. An infill base building, typically five stories in height, (with the portion along Purchase Street rising from five to nine stories) will be constructed between and around the two taller building elements and will include as its major design feature an interior landscaped atrium of approximately 23,000 SF.

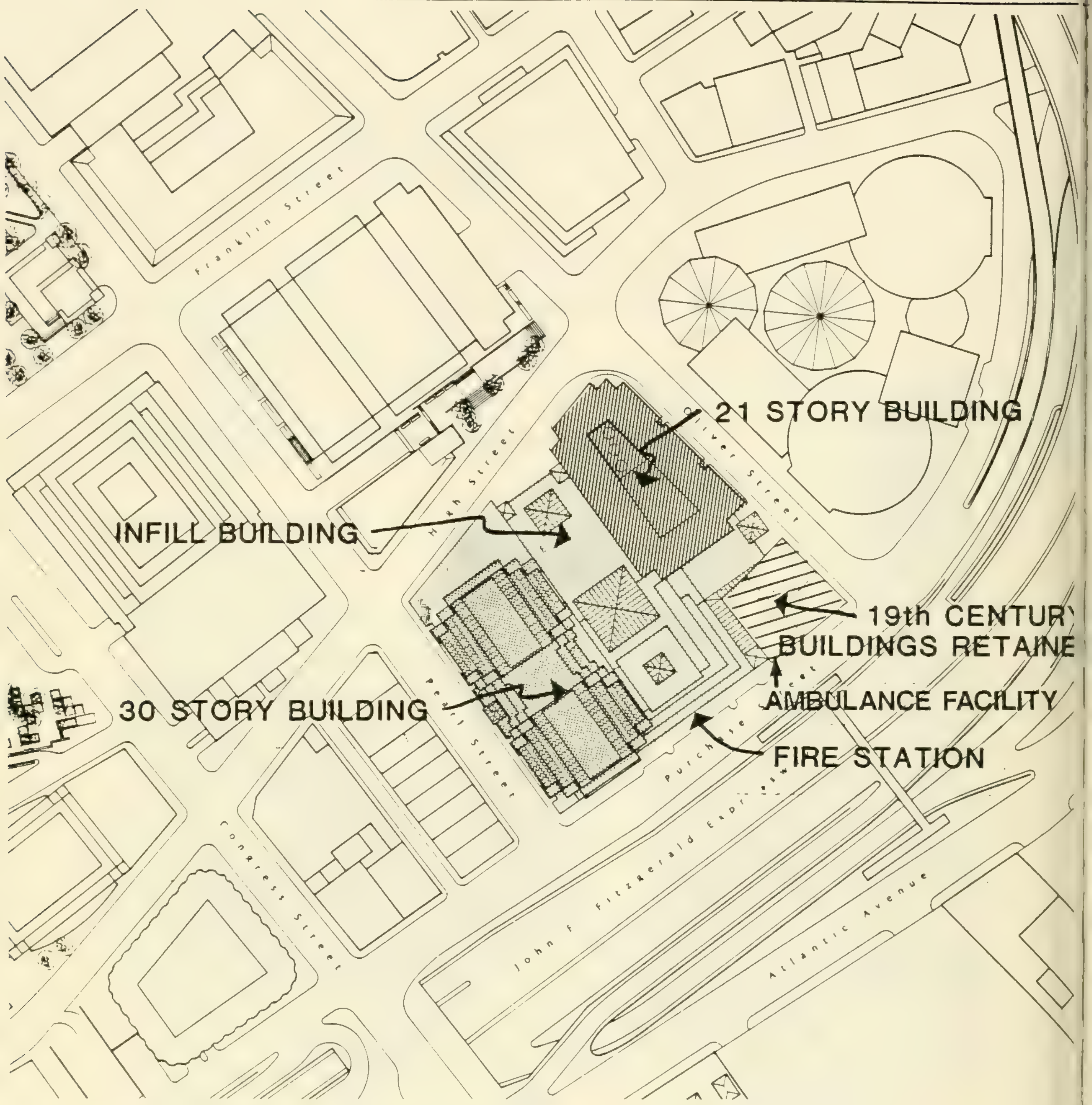

FIGURE 4-11 PROPOSED PROJECT

ONE TWENTY FIVE HIGH STREET

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Glass entrances will link the buildings through the 3- to 9-story infill base building. All of the proposed building elements will surround this glass-enclosed atrium. The atrium will act as an indoor courtyard, and will be directly accessible to pedestrians through three entrances: High Street, Pearl Street, and Oliver Street. Additionally, lobbies of the two main buildings will have areas that lead to, and open onto the atrium. Easy access may also be possible through the retail storefronts that line the ground floor along High, Oliver, and Pearl Streets. It is expected that pedestrians will walk through the project as well as around it. The climate-controlled atrium will be landscaped, and will serve as an interior courtyard, with plantings and seating. Restaurant and/or retail services will be primarily located on the first level and will either be part of the courtyard or accessible from it. The proponent is planning the atrium to bring 12-hour per day activity to the site.

The uses of the buildings will be primarily for office space. The upper stories of both main buildings, as well as a part of the renovated 19th century structures, will be used for office purposes. The 30-story building will contain approximately 849,600 SF of office space and approximately 15,600 SF of new retail space. The 21-story building will contain approximately 438,900 SF of office space and approximately 9,400 SF of retail space. The three 19th century buildings will contain approximately 45,000 SF of office space and approximately 3,900 SF of retail space. The street level spaces, including the atrium, will mainly be used for neighborhood shops and/or restaurants which will cater primarily to office workers in the area.

In addition to retail space, the ground levels will include building lobbies, and parking garage access/egress points. The buildings will be served by central cores for elevator, mechanical and service uses.

Parking will be provided on approximately six underground levels with approximately 850 parking spaces. This below grade parking facility will also include approximately nine loading bays for trucks. Parking and truck access will be from Purchase Street, while pedestrian access to the garage will be through elevator and stairway locations in the lobbies of both main buildings, adjacent to the atrium.

At ground floor levels, the completed project will have a mix of retail, landscaped areas, a new fire station, a City of Boston ambulance facility, and restored 19th century buildings. Amenities will include use of the public areas and retail as well as availability of public parking. The buildings' location in the Financial District and proximity to major projects like International Place increases the importance of these public amenities. Office workers and pedestrians in the area, as well as adjoining blocks, can avail themselves of the public amenities and not have to seek restaurants, shops, and parking very far from where they work.

The next set of figures illustrates proposed new construction through various typical floor plans of the buildings, below-grade parking, sections of the project, elevations from all four sides, photographs of the model and renderings of the completed project.

Figure 4-12 depicts the ground floor plan with the atrium in the center, surrounded by lobbies, retail and the fire station (to the south along Purchase Street). The ground floors of the 19th century buildings at the lower right corner are also designated for retail use and a City of Boston ambulance facility. Figure 4-13 depicts the third floor,* indicating that the two main buildings and the renovated 19th century buildings are connected through the infill base building. Figure 4-14 illustrates the sixth floor, showing

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* Note: The schematic drawings are in the process of being revised to accomodate a 2-story fire station, rather than a 3-story fire station.

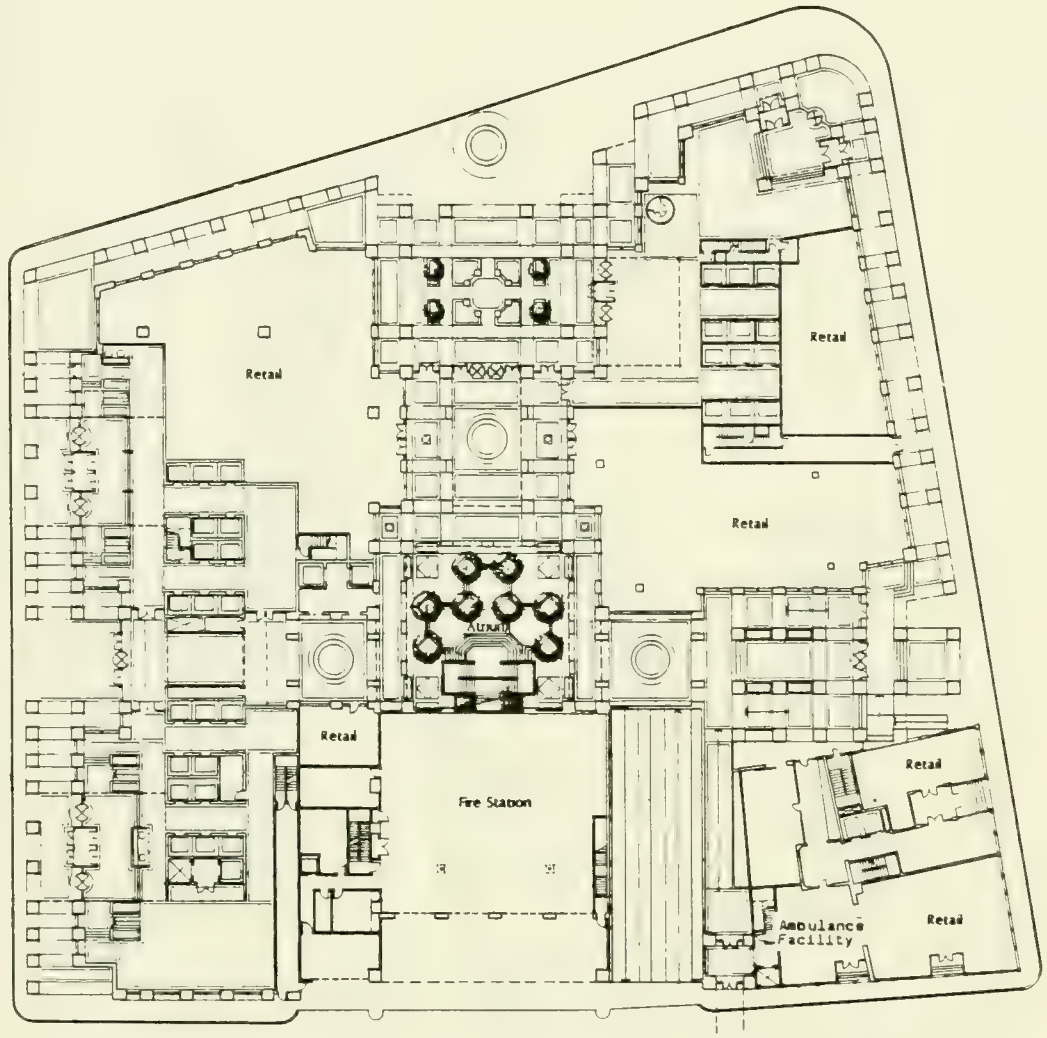

FIGURE 4-12 GROUND FLOOR PLAN

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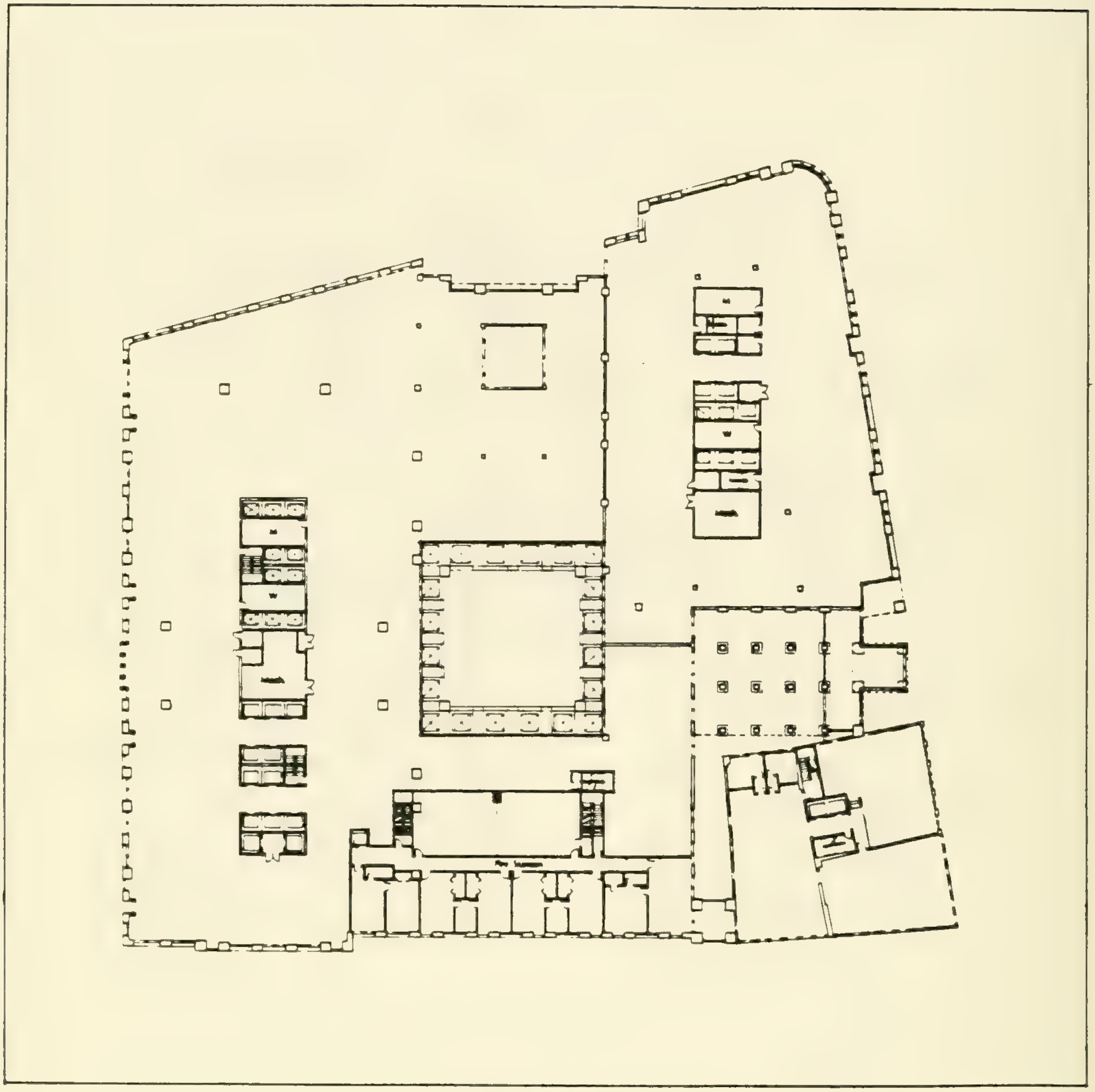

FIGURE 4-13

Third Floor

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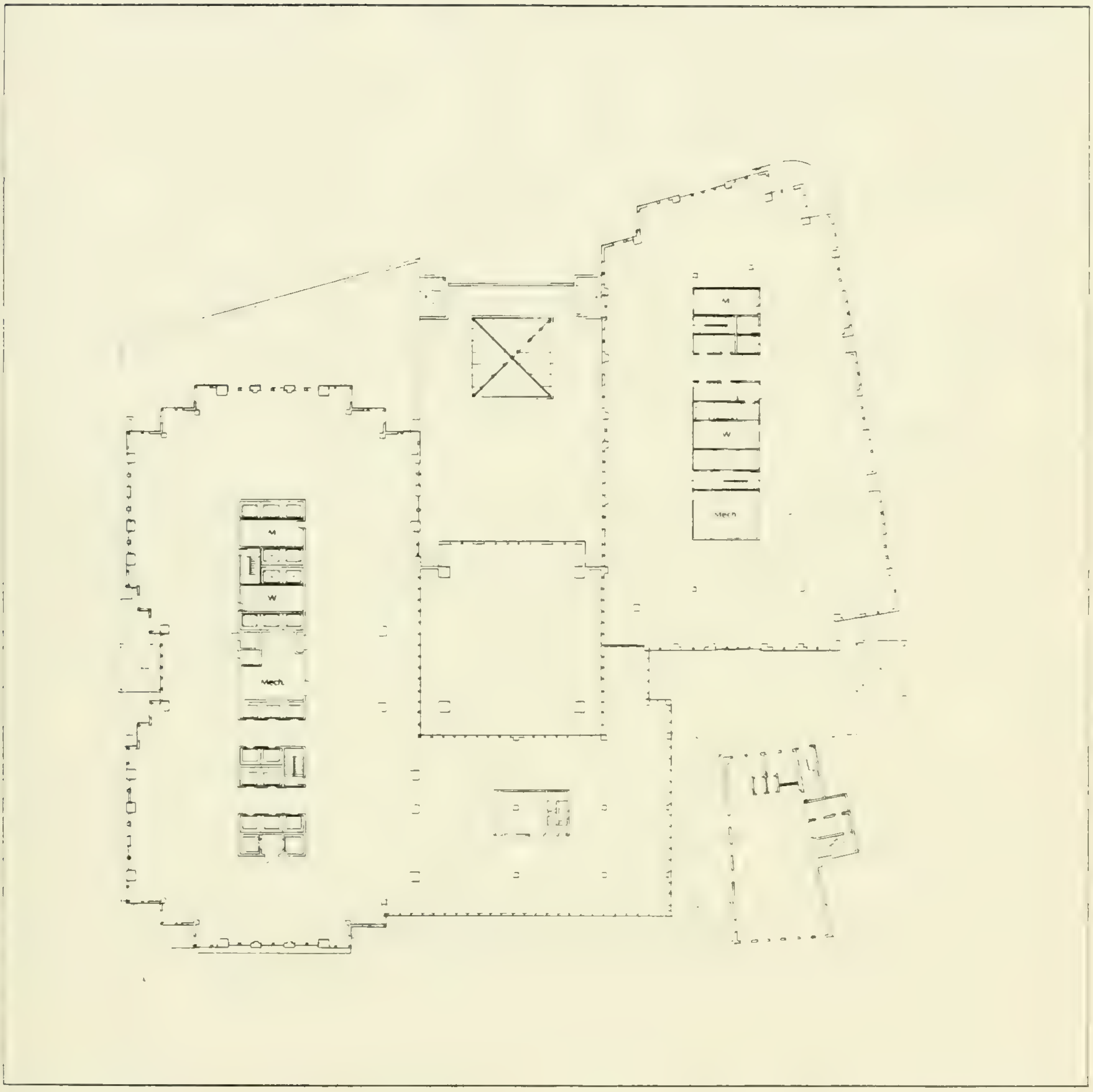

FIGURE 4-14

Sixth Floor

ONE TWENTY FIVE HIGH STREET

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that the two main buildings are still partially connected by the upper levels of the infill base building. Figure 4-15 illustrates typical floor plans from levels 10-18. This shows the roofs of the infill base building, the fire station and the 19th century buildings. At these mid-rise levels, the two main buildings are no longer connected, each having its own mechanical and elevator cores. Figure 4-16 shows the two buildings at their high-rise levels. Figure 4-17 shows the 30th floor of the tallest building and the roofs of the 21-story building and of all other buildings on site.

The below-grade parking will be on approximately six levels. Figure 4-18 shows the first level, depicting ramps along the south side, Fire Department parking, tenant parking, and service/loading docks. Figure 4-19 shows level 3 which is typical of the other levels of parking.

Figure 4-20 illustrates a section of One Twenty Five High Street running east/west. Shown in the center is the atrium and to the left, the 30-story building. Below grade parking levels are also shown. Figure 4-21 is also a section of the new development, but this view cuts through a north/south axis. Again, the atrium is prominent in the center with the variable heights of the infill base building on either side of it.

Figures 4-22, 4-23, 4-24, and 4-25 are illustrations of building elevations on each side of the block. Figure 4-22 is a view along High Street. The 30-story building is on the right and the 21-story is on the left. The entrance to the atrium is seen in the middle. The pedestrian arcades are also visible at street level along the perimeter of the property. Figure 4-23, the Pearl Street elevation, shows the 30-story building in the foreground of the illustration, with the 21-story building behind it and to the left. The mid-block entrance to the building is visible, as are the pedestrian arcades on both sides of the entrance. Behind One Twenty Five High Street, the International Place Tower is visible from this vantage point. The Purchase Street elevation (Figure 4-24),

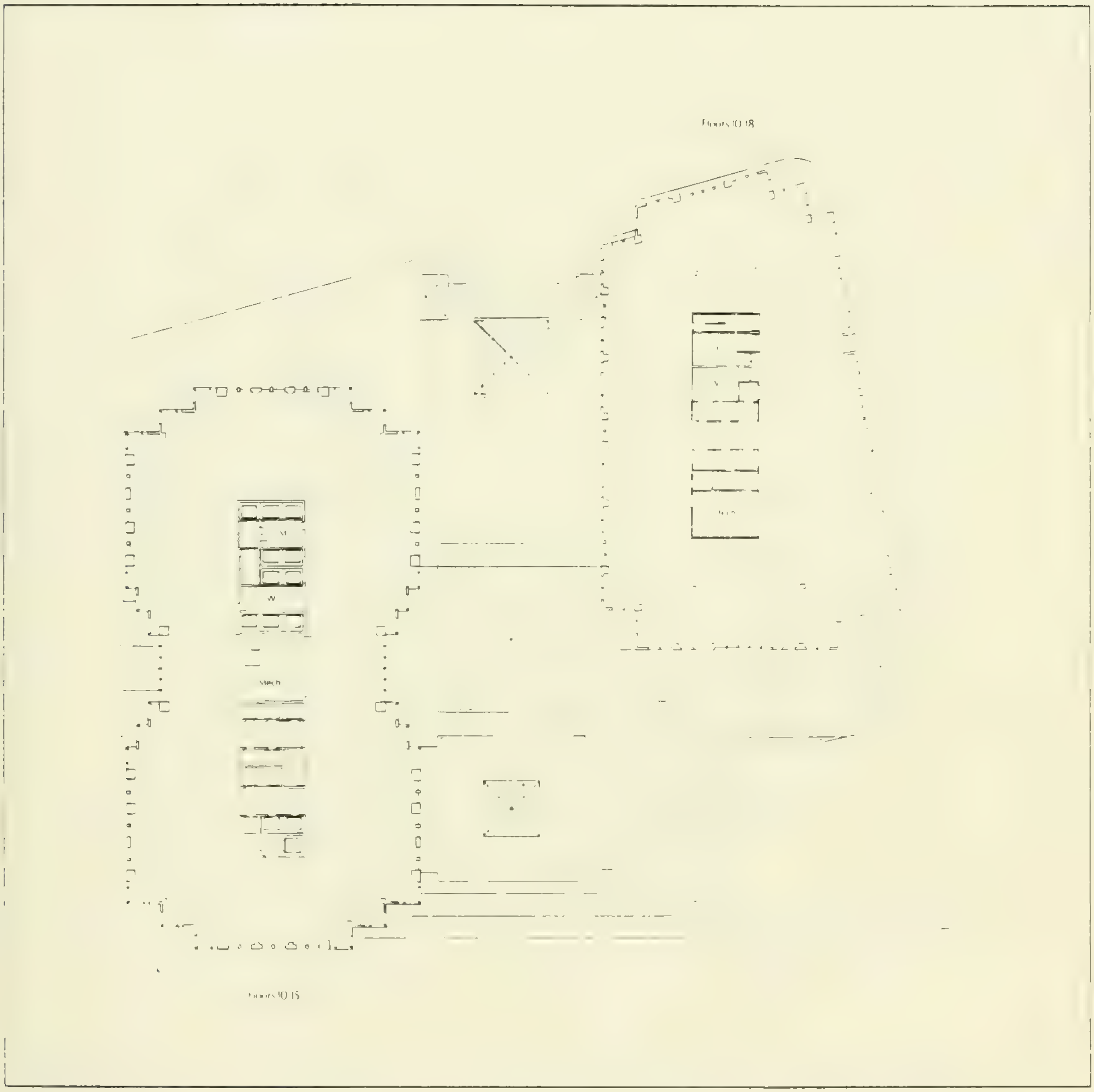

FIGURE 4-15 MID RISE FLOORS

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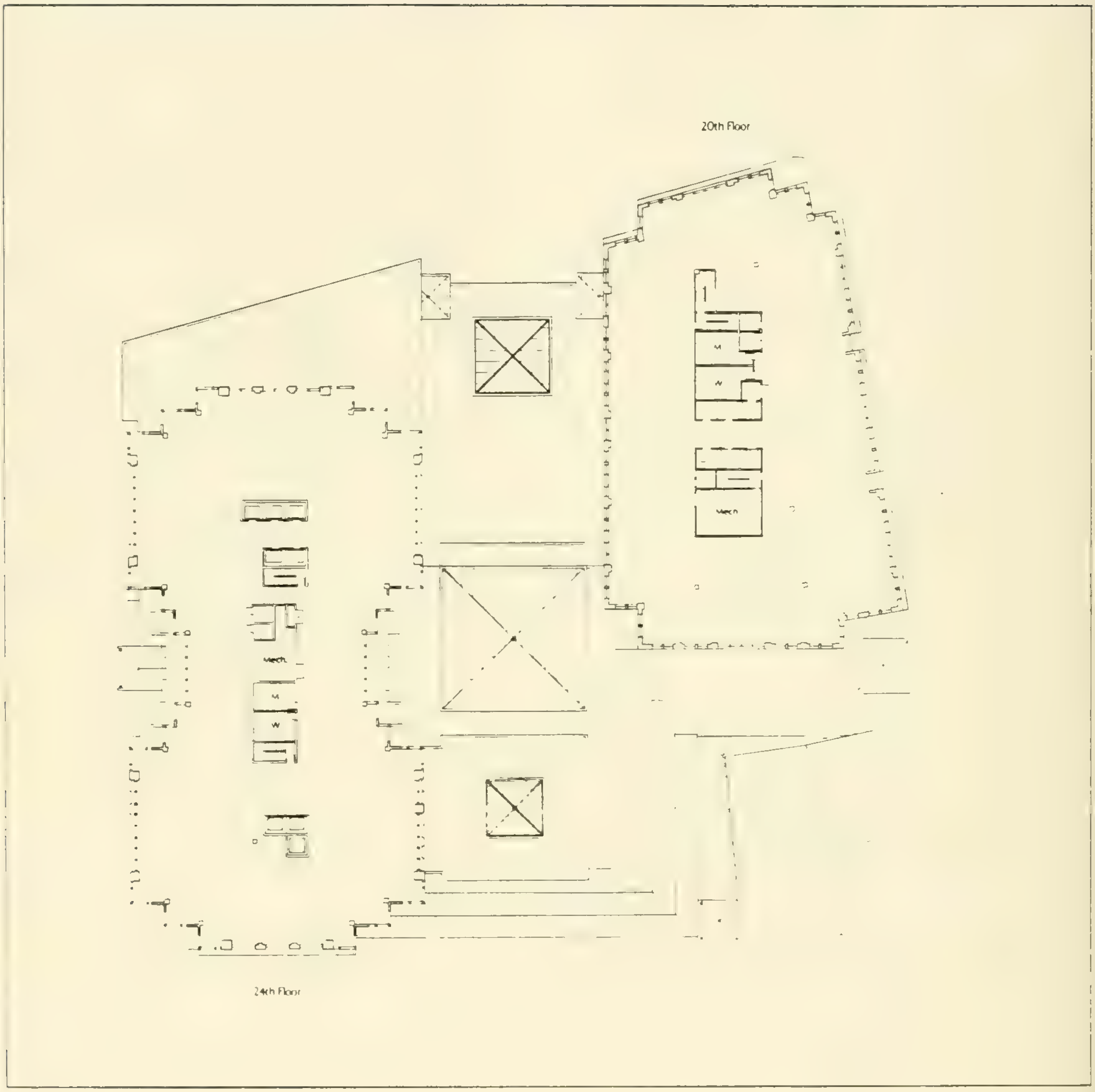

FIGURE 4-16 HIGH RISE FLOORS - 20TH AND 24TH FLOORS

ONE TWENTY FIVE HIGH STREET

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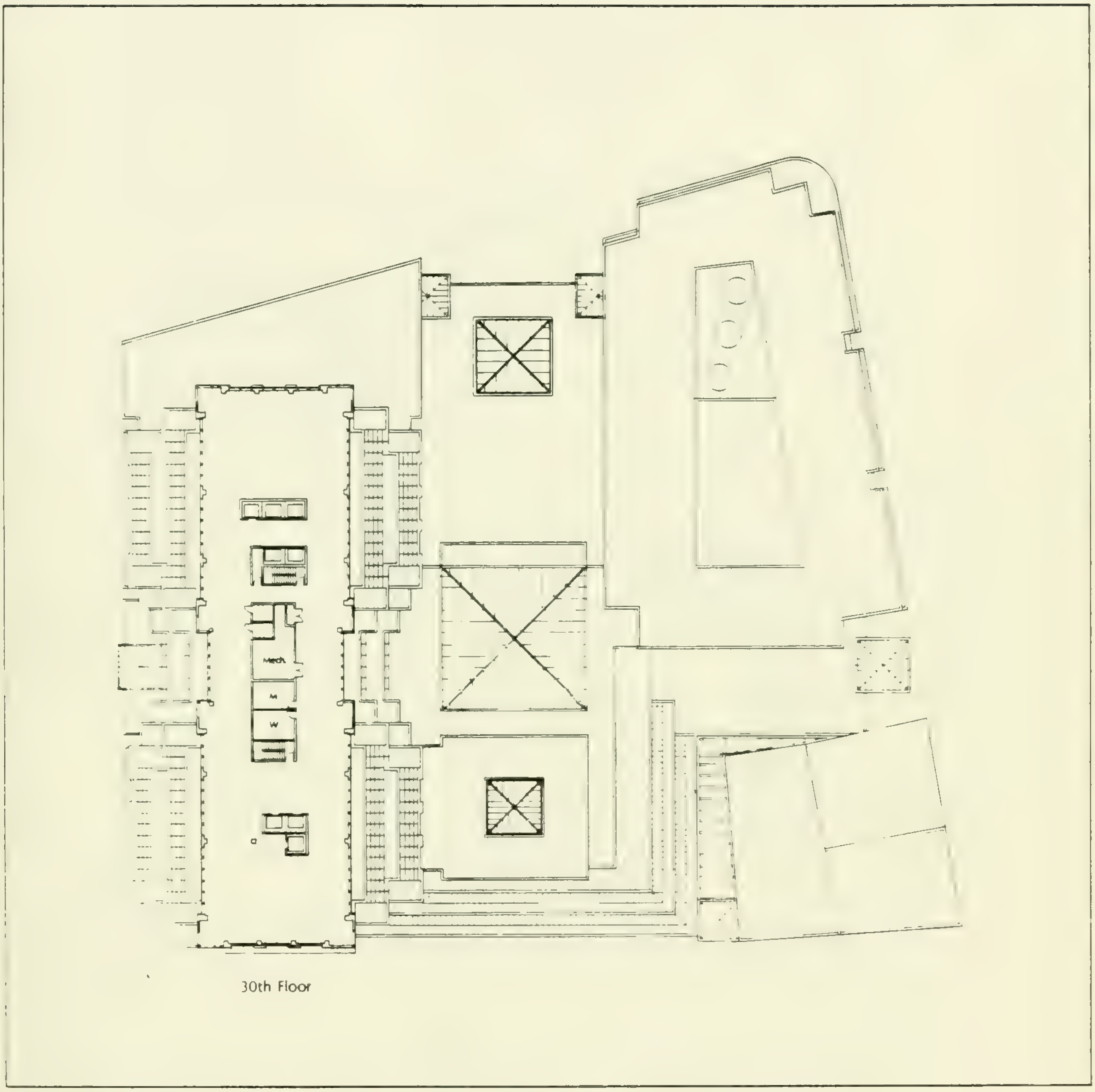

FIGURE 4-17 HIGH RISE FLOORS - 30TH FLOOR

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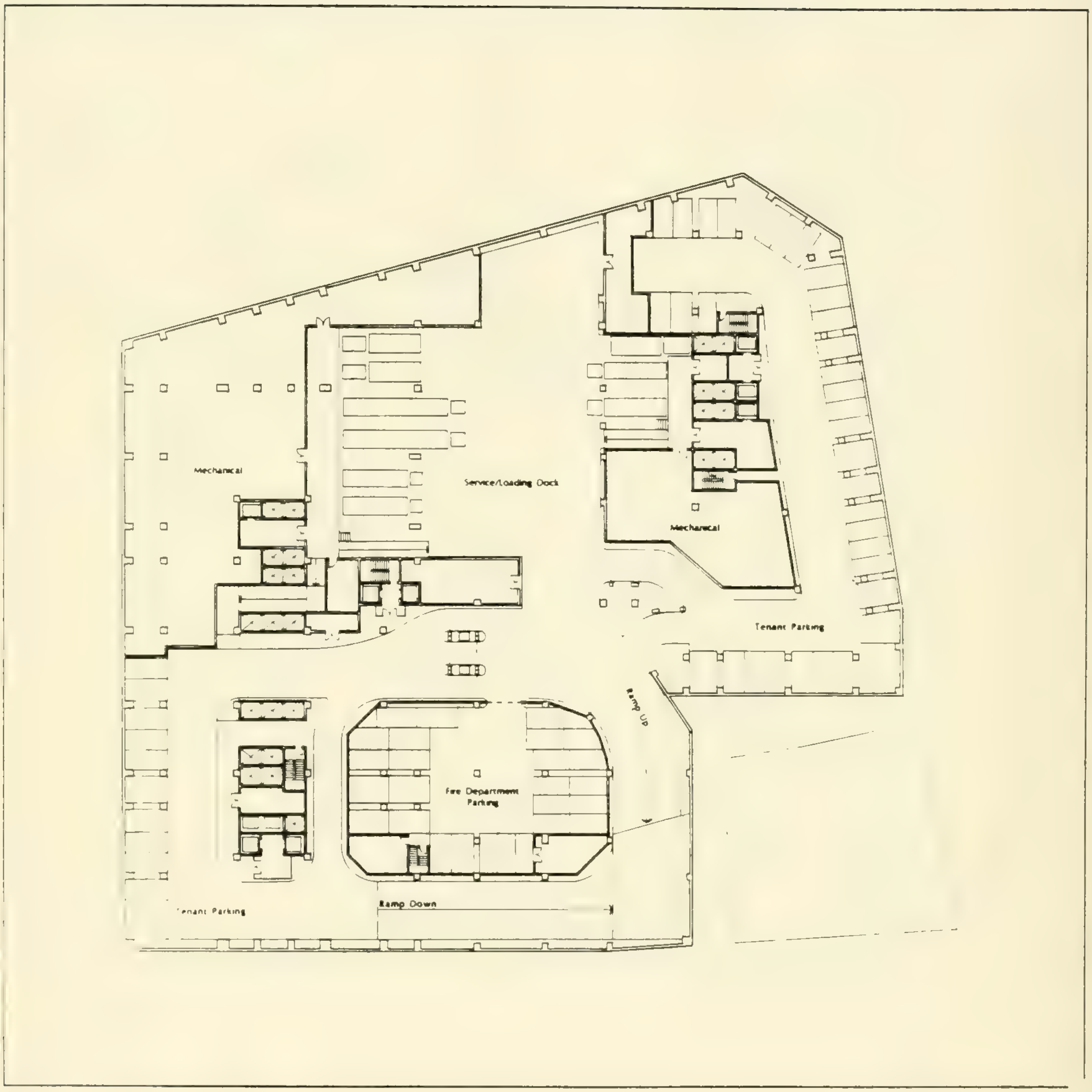

FIGURE 4-18 PARKING - LEVEL 1

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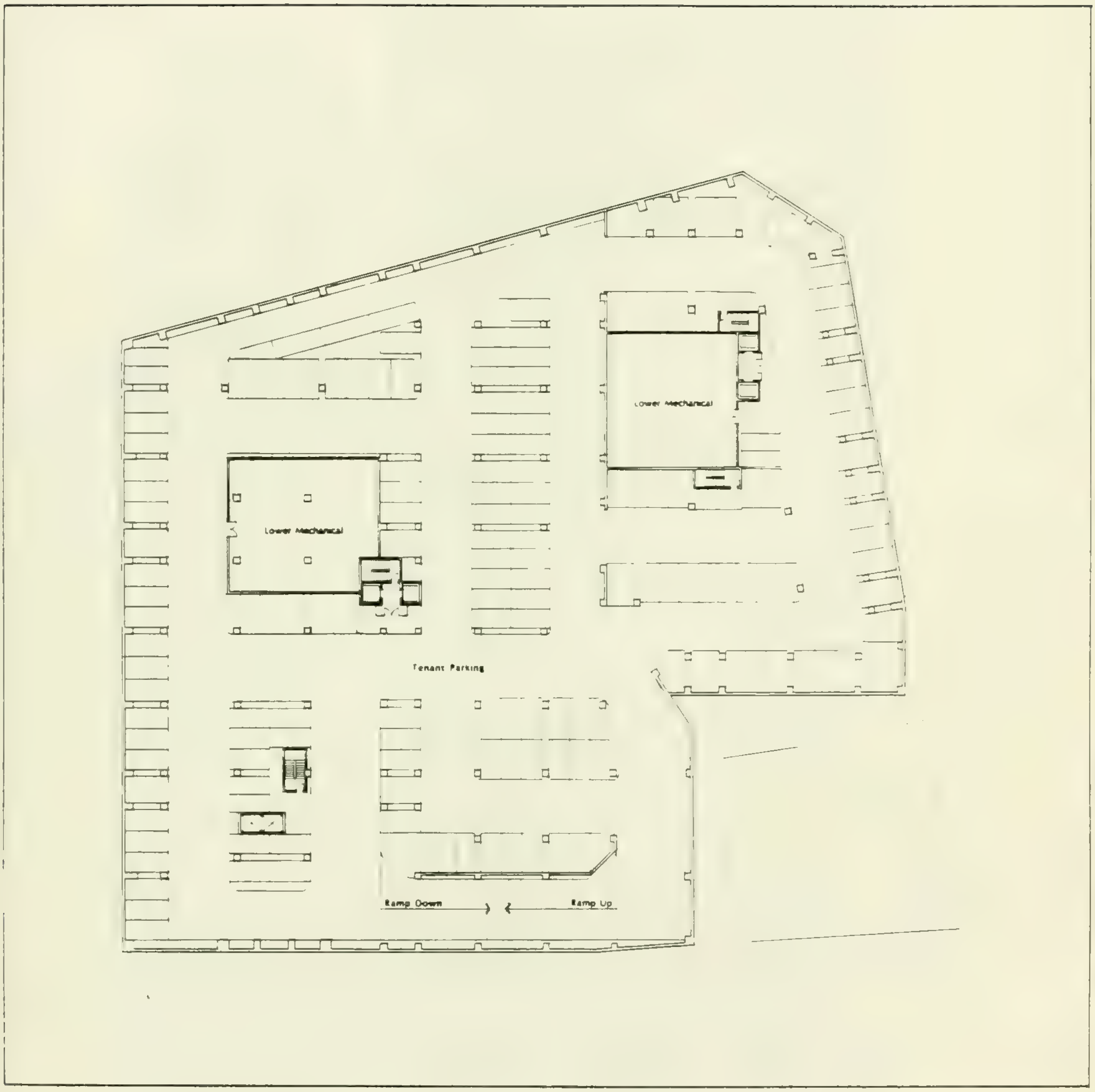

FIGURE 4-19 PARKING - LEVEL 3

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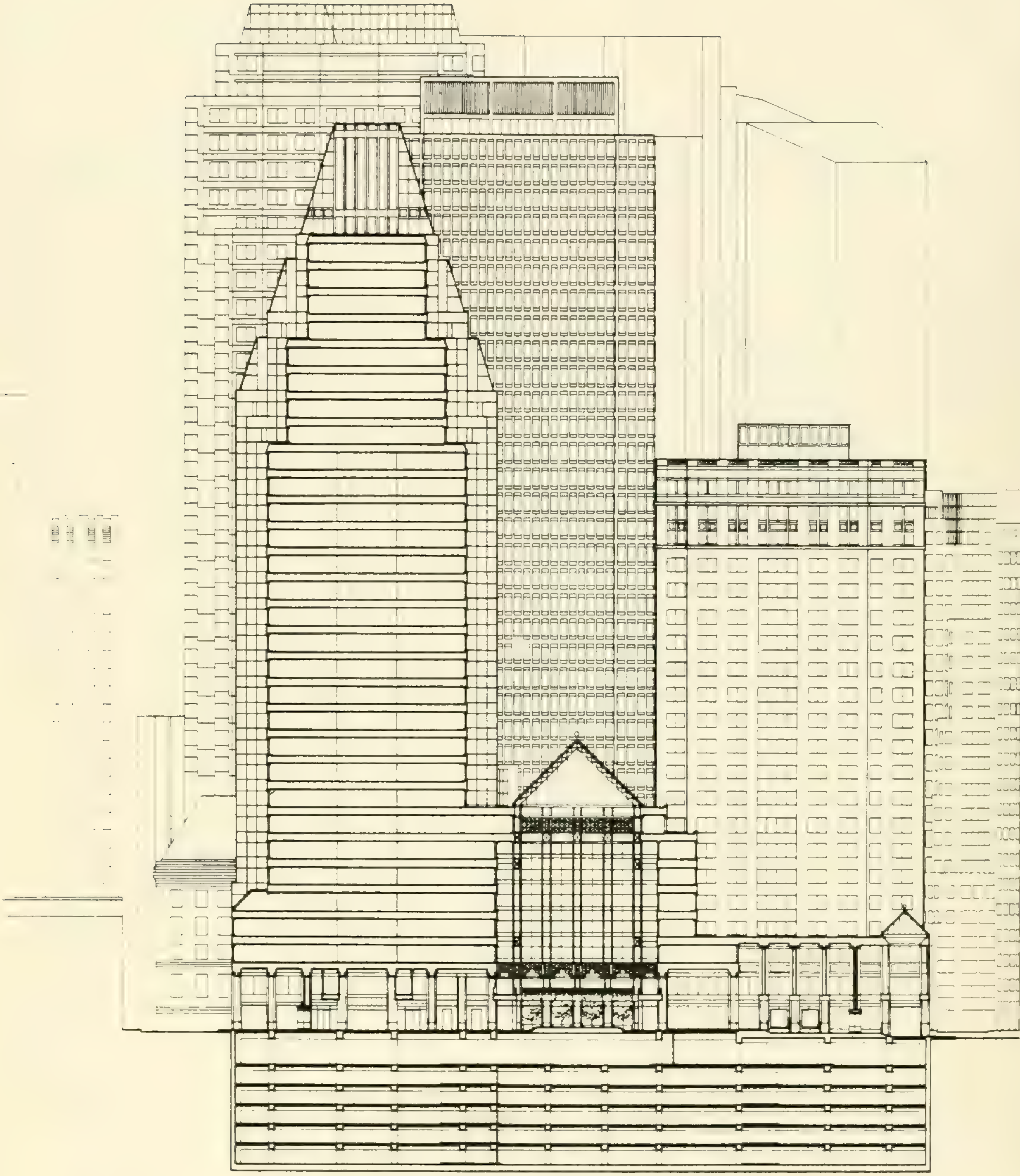

FIGURE 4-20 SECTION A-A

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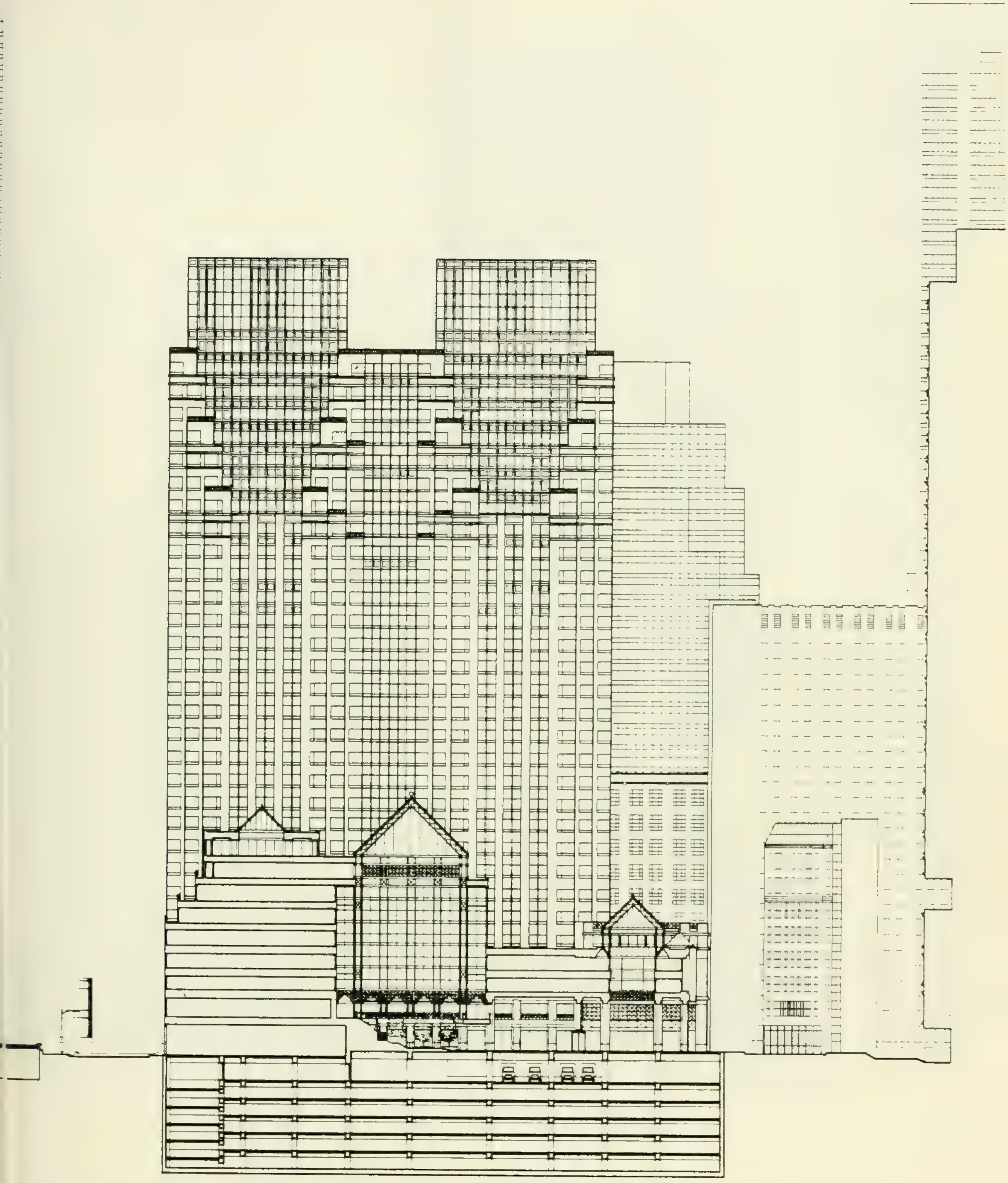

FIGURE 4-21 SECTION B-B

ONE TWENTY FIVE HIGH STREET

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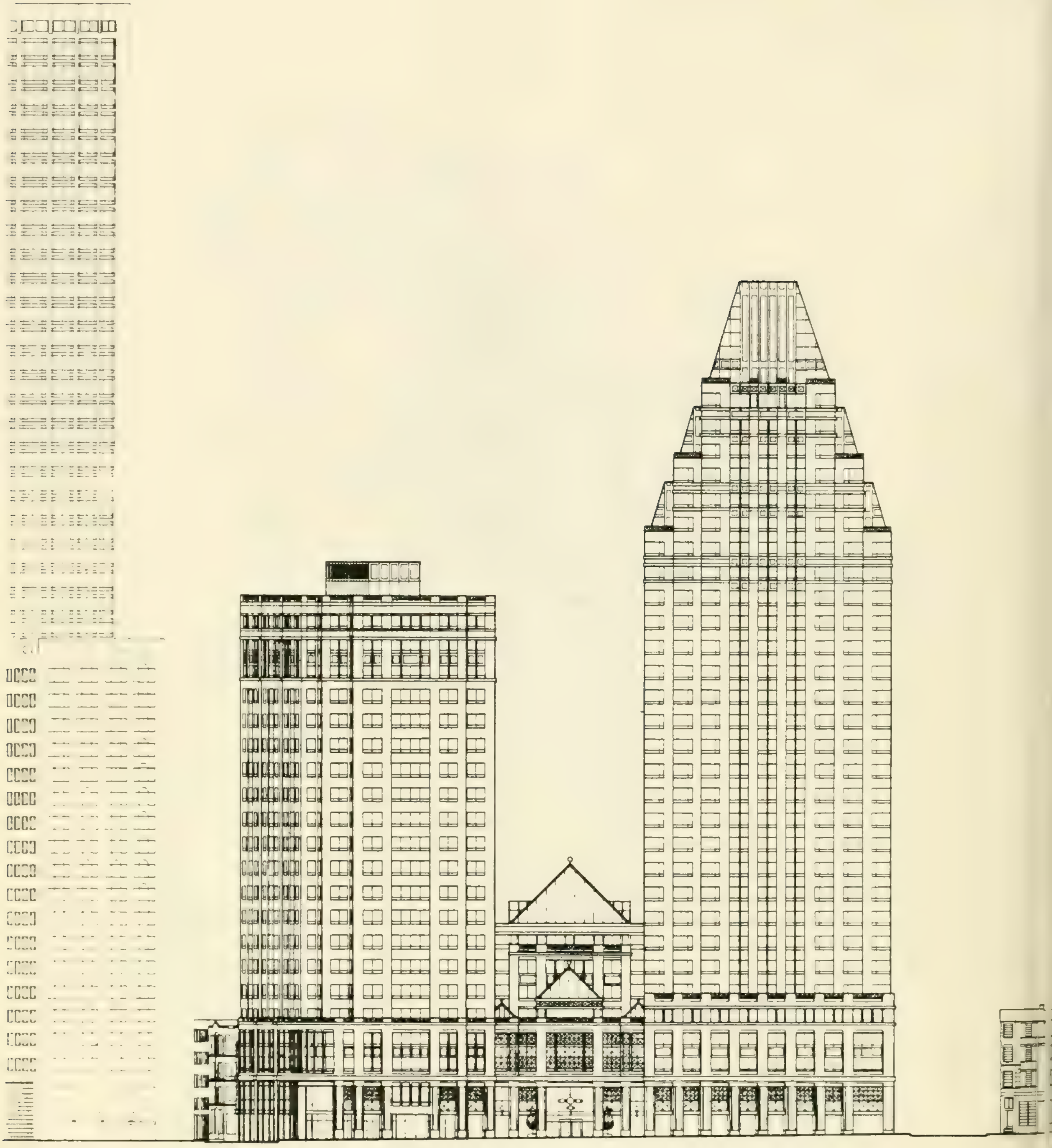

FIGURE 4-22 HIGH STREET ELEVATION

ONE TWENTY FIVE HIGH STREET

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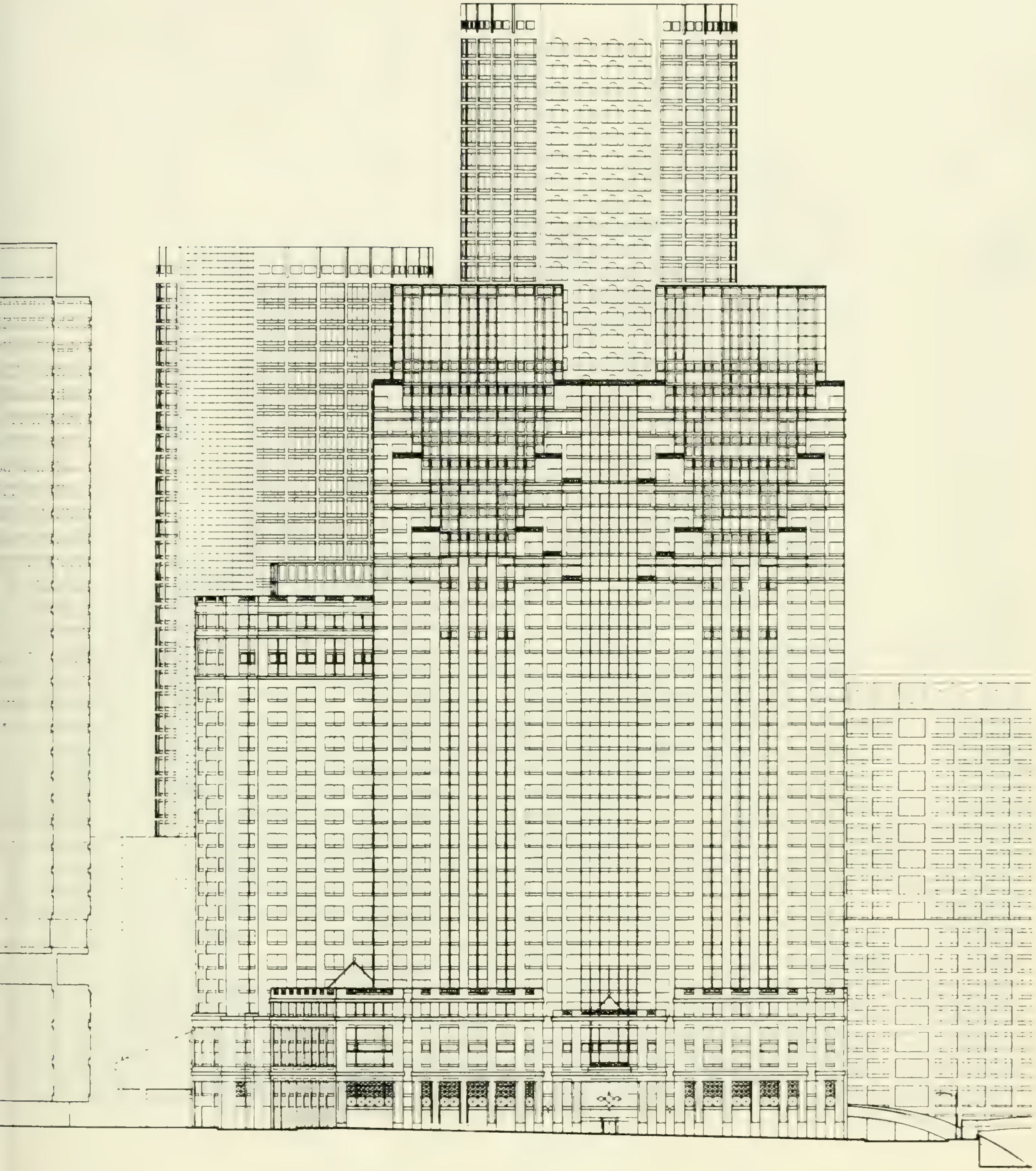

FIGURE 4-23 PEARL STREET ELEVATION

ONE TWENTY FIVE HIGH STREET

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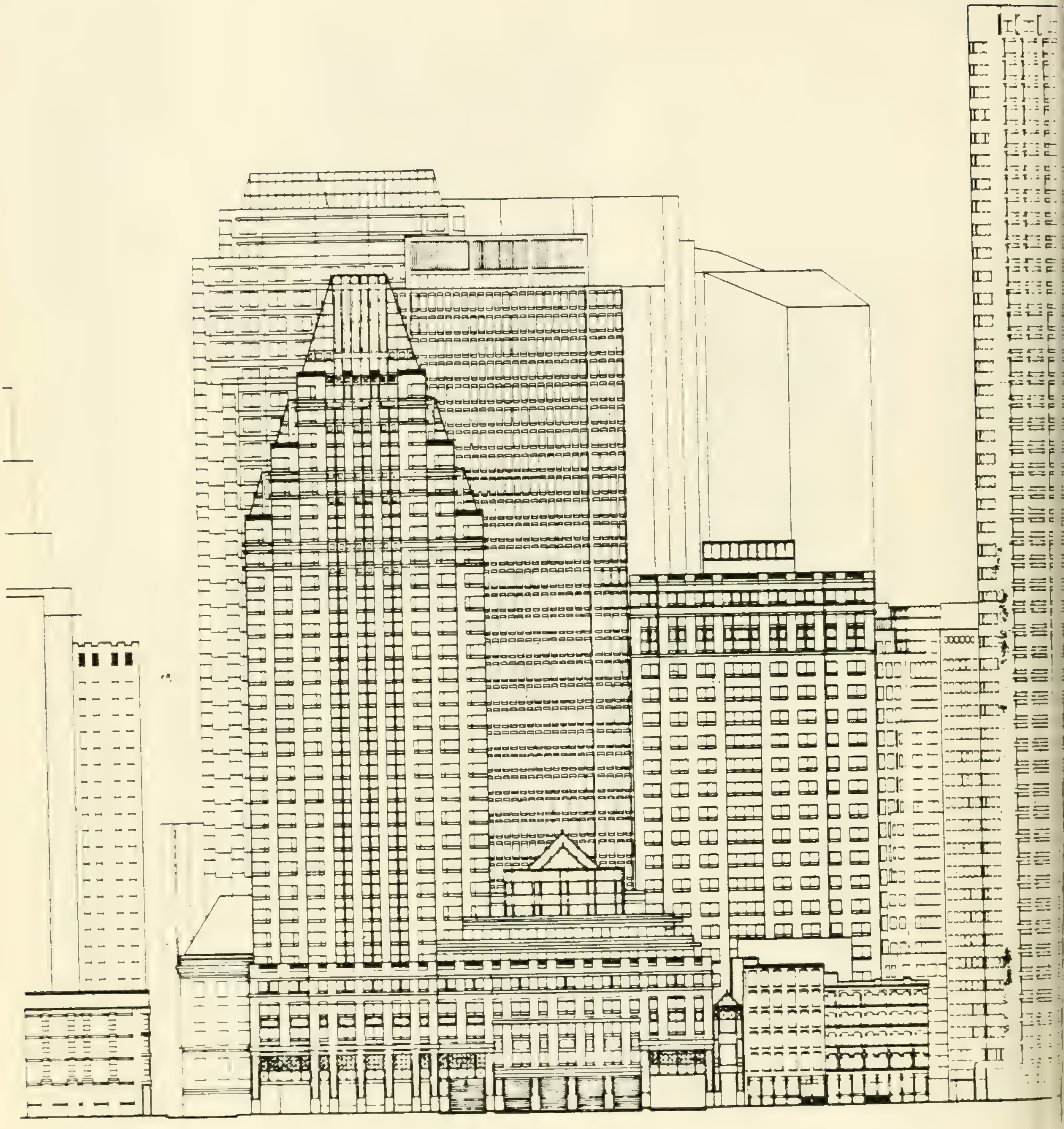

FIGURE 4-24 PURCHASE STREET ELEVATION

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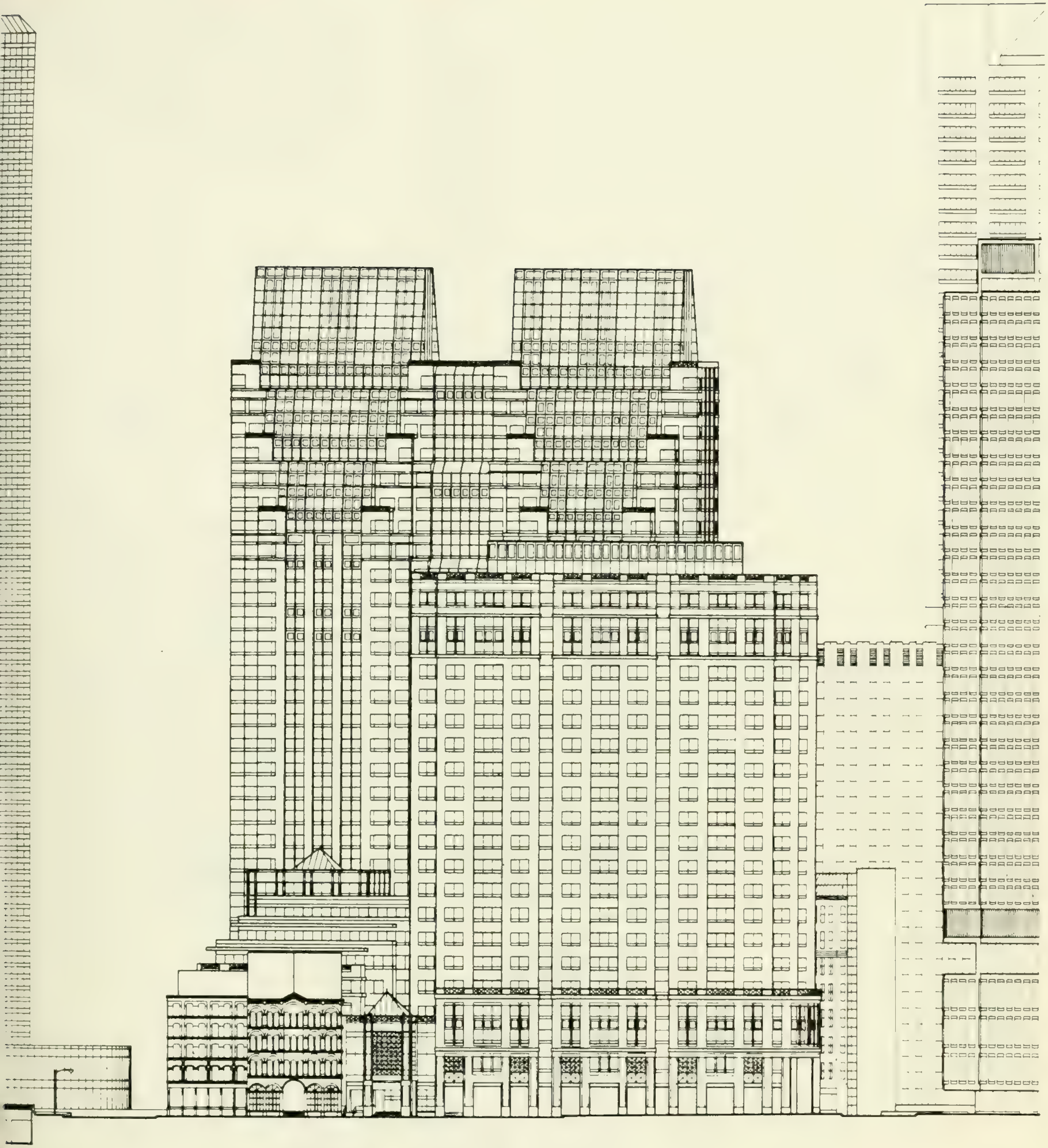

FIGURE 4-25 OLIVER STREET ELEVATION

ONE TWENTY FIVE HIGH STREET

Jung/Brannen Associates, Inc. Architects and Planners One Twenty Five High Street Limited Partnership

11.17.86

which faces the Central Artery, shows the front entrance to the relocated fire station, the parking garage entrance/exit and the renovated 19th century buildings (in the right corner). Looking above the infill base building, the 30-story building is seen on the left and the 21-story building on the right. Both main buildings are seen against a back-drop of taller existing buildings. Finally, the Oliver Street elevation (Figure 4-25) shows the 19th century buildings on the left and the pedestrian arcades along the base of the 21-story building. The 30-story building is partially visible in the rear. Figure 4-26 shows a detail of the new entrance along Oliver Street at the point where the 19th century building (left) meets the base of the 21-story building.

Figure 4-27 shows a photograph of the scale model of One Twenty Five High Street. The view is looking towards Purchase Street with a portion of Pearl Street visible. The 30-story building is shown in the foreground, with two sides clearly visible. Figure 4-28 is an artist's rendering which shows the 21-story building on the right and the 30-story building on the left. Both figures illustrate how the two main buildings are joined at the lower levels by the infill base building and how the fire station and 19th century buildings are also integrated into the overall design of the complex.

Figures 4-29 and 4-30 illustrate the relationship of One Twenty Five High Street to its immediate surroundings and against the Boston skyline.

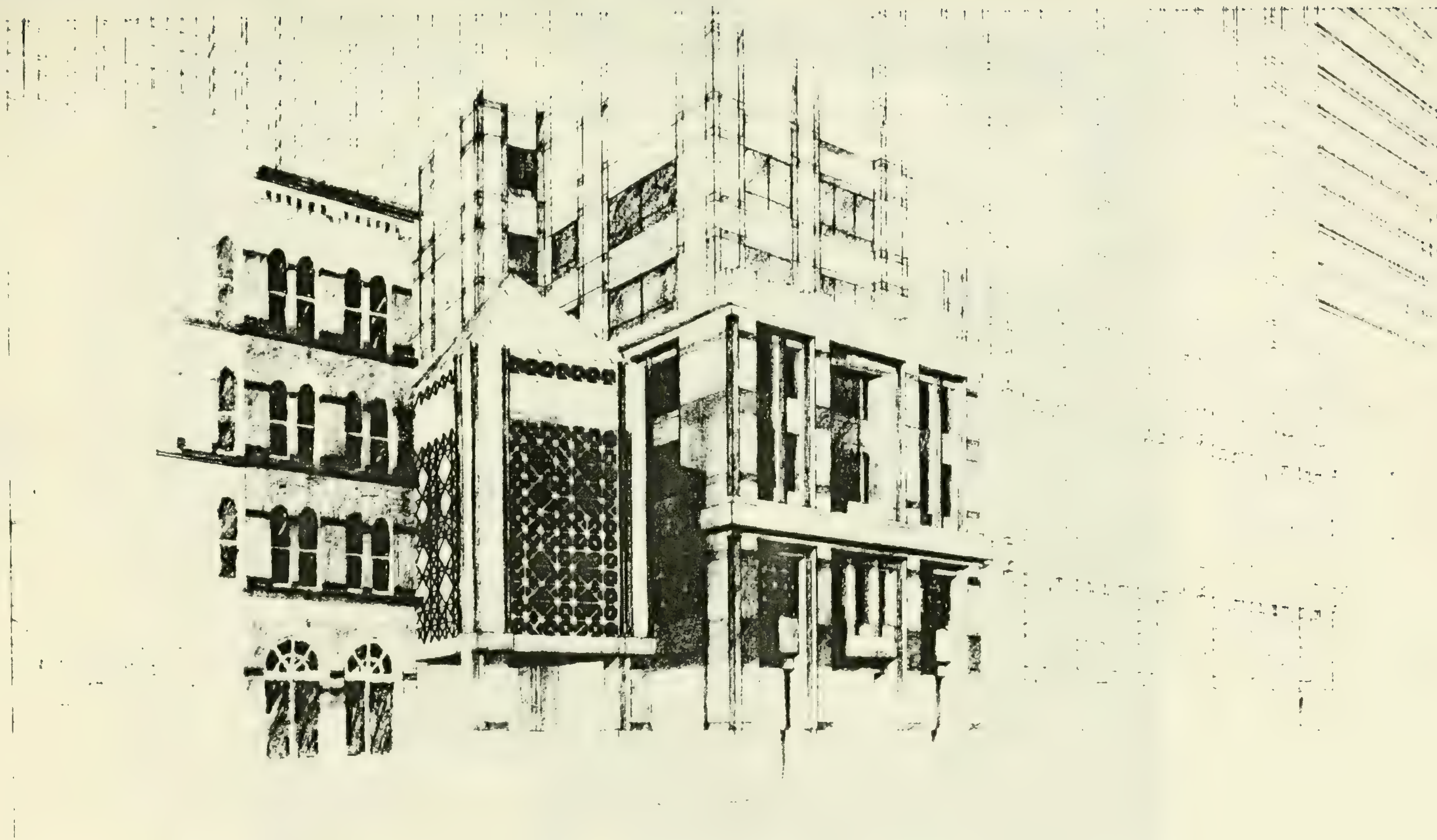

FIGURE 4-26 DETAIL - OLIVER STREET

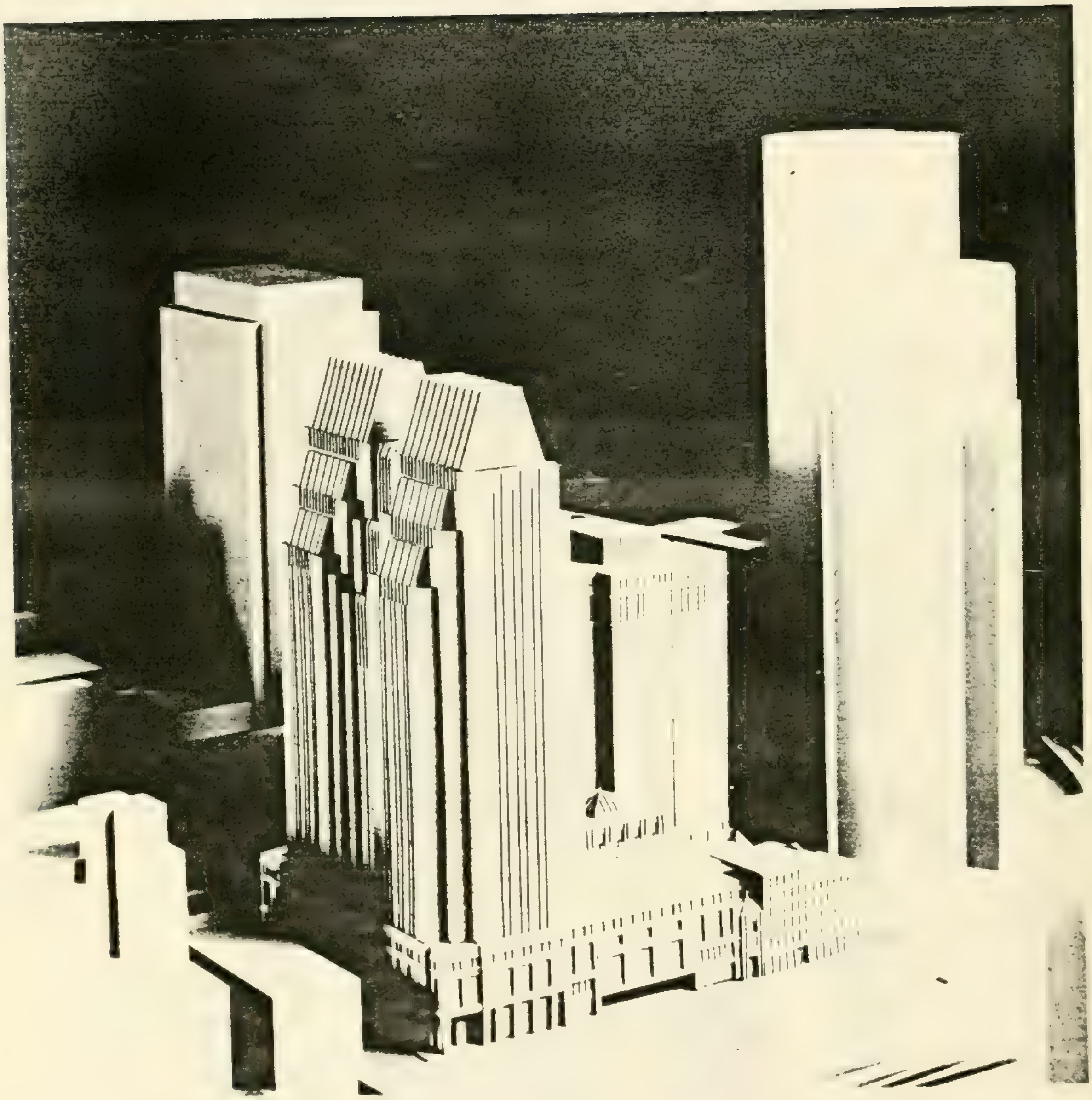

FIGURE 4-27 MODEL - PURCHASE STREET

FIGURE 4-28 ARTIST'S RENDERING - VIEW FROM ACROSS CENTRAL ARTERY

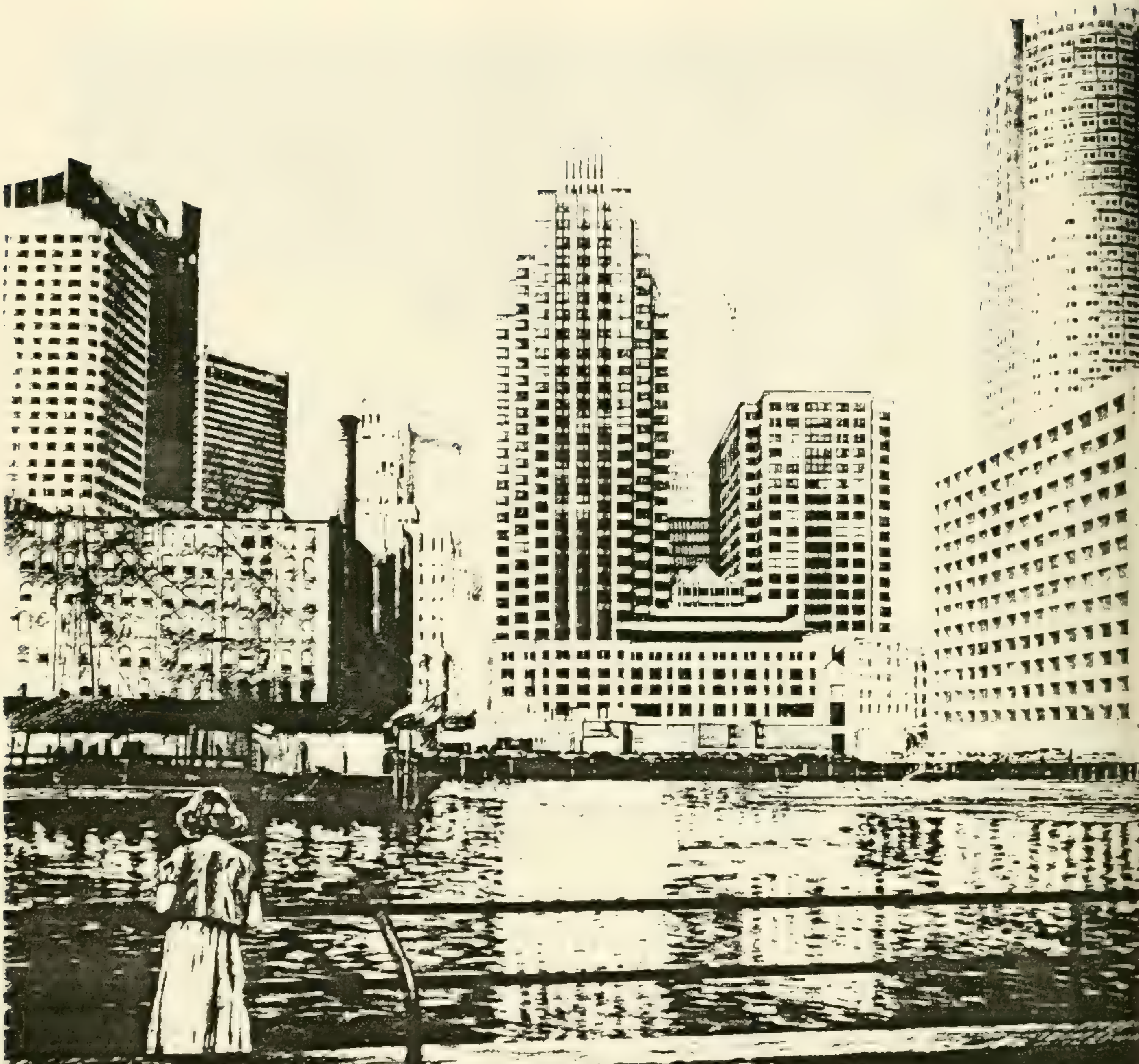

FIGURE 4-29 VIEW FROM ACROSS FORT POINT CHANNEL

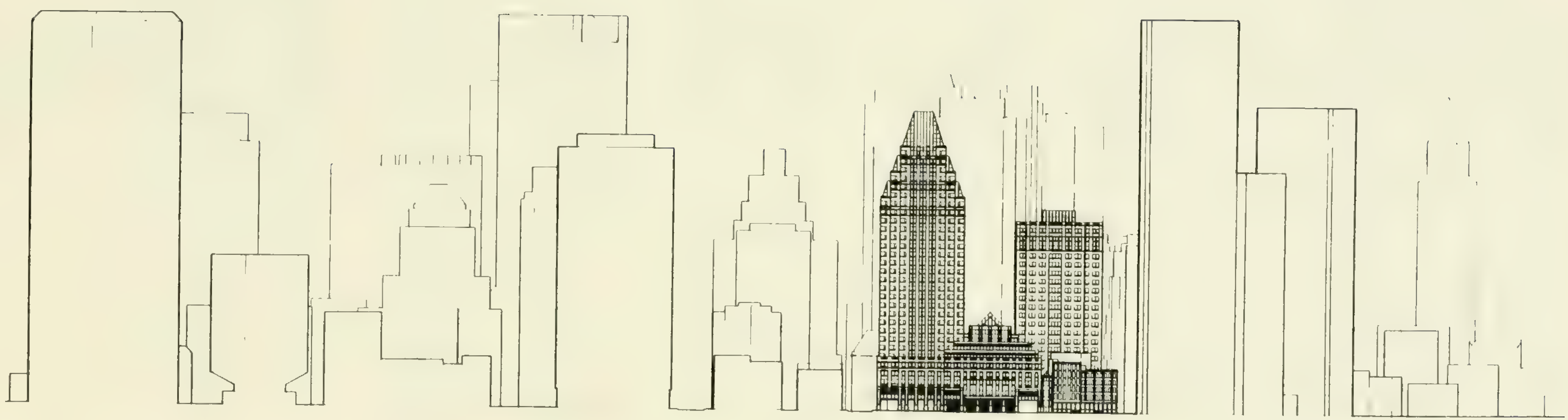

FIGURE 4-30 BOSTON SKYLINE

ONE TWENTY FIVE HIGH STREET

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11.17.86

4.4 Project Objectives and Benefits

Fort Hill Square remains, even after the current development of International Place, one of the last sizeable underdeveloped sites in the Financial District capable of supporting a major development. The following project objectives reflect the BRA's goals for the site:

- o Convert an underdeveloped downtown site into a physical and financial asset.
- o Bring activity to the development area for 12 hours a day.
- o Offer ground floor retail and public amenities which will serve the immediate neighborhood and act as catalysts for improvements in the adjacent lower Broad Street area.
- o Replace parking spaces currently on the site.
- o Design the project to accommodate plans to depress the Central Artery.
- o Meet the increasing demand for first class office space in the City's financial district.
- o Relate to the scale and materials of both nearby office buildings and the Customs House Historic District.
- o Preserve existing views of the harbor.
- o Develop a pedestrian link with new downtown waterfront development, especially Rowes Wharf.

By redeveloping an area that now acts as a barrier between the healthy areas of the City and under-utilized sections of the City, One Twenty Five High Street will be an important stimulus or link, to desired new growth in less developed areas in the downtown, waterfront, and the area across Fort Point Channel. In addition to its connection with other developments, One Twenty Five High Street will contribute the following specific benefits to the City:

- Approximately $5.6 million in estimated annual property taxes on completion.

- Approximately 630 construction jobs over the construction period.

- 4,700 projected permanent jobs in the completed development.

- Improvement to project boundary streets by providing storefronts, especially on High Street.

- Significant improvement to the public amenities at street level.

- Construction of a climate-controlled indoor atrium of approximately 23,000 SF.

- Provision of approximately 850 underground parking spaces on-site with the following approximate assigned uses:

150	Public spaces.
30	Fire Department spaces.
7	Ambulance Facility spaces.
105	Replacement of existing spaces on-site.
558	Building occupants' spaces.
850	Total spaces.

- Bringing approximately 23,000 SF of retail activity to an under-serviced area.

- Keeping one of Boston's prime employers, New England Telephone, in a Boston location.

4.5 Project Timetable

It is intended that One Twenty Five High Street will be constructed within approximately six years. The approximate sequence of major construction elements follows:

- Commence renovation of 19th century buildings -- Spring-1988 to Summer-1989.

- Commence demolition of Travelers Building -- Fall-1987.

- Construction of 30-story building -- Spring-1988 to Spring-1991.

- Completion and occupancy of new ambulance facility at Purchase Street -- Spring-1990.

- Completion and occupancy of new fire station at Purchase Street, and commence razing existing station -- Spring-1990.

- Construction of 21-story building -- Summer-1990 to Fall-1992.

The development site has excellent geological characteristics for construction. The two main structures will rest on concrete footings with a structural steel and concrete deck frame. The building elements will include brick for the 19th century buildings, and glass, granite, metal panels, and possibly marble, cast stone or limestone for the new buildings. Energy efficiency has been incorporated into the design.

4.6 Project History

The proponents have been working with the BRA for 22 months in the evolution and development of the project. The process and progress achieved over those months is illustrated by the submissions outlined and illustrated in the following pages.

Prior to submitting any design concepts or drawings, the development team conducted an extensive site analysis which was presented to the BRA. After that presentation, which included a definition of the program elements (Item I in the summary of submissions below), a number of meetings were held to discuss conceptual massing approaches. These are represented by Item II in the summary. At the request of the BRA, there ensued a larger number of massing alternative studies, which are summarized by the seven illustrated Schemes A through F and the current proposal, Scheme G. The proposed design of One Twenty Five High Street is the result of this long iterative process between the developers and the BRA. It has resulted in a project that balances design issues and public benefits with the developer's financial constraints.

4.7 Summary of Submissions

I. Program Elements

- o Blocks illustrating conceptual massing locations.
  - 600 foot tower at Oliver and High Streets.
  - 390 foot building at Pearl and Purchase Streets.
- o Preferred scenario relocates fire station.

II. Concept Diagrams

- o "Open" (courtyard) and "closed" (atrium) concepts applied to schemes that keep existing fire station vs. relocating the fire station.

III. Massing Alternatives

Scheme A

- o 555 foot Phase I tower at High and Oliver Streets.
- o Existing Travelers Building remains in operation until completion of Phase I.
- o Fire station relocated to Purchase Street.
- o Vehicular access/egress on Oliver Street.
- o Atrium at center of site with courtyard at mid-block along Purchase Street.
- o 19th century buildings at Purchase and Oliver Streets demolished.
- o 400 foot Phase II building at Purchase and Pearl Streets.

Scheme B

- o Phase I tower is reduced to 507 feet in height and shifts to Pearl Street -- minimize canyon effect along Oliver Street; maximum distance from Phase I tower at International Place.
- o Owners committed to demolition of existing Travelers Buildings prior to Phase I construction.
- o Phase I split into 2 components.
- o Vehicular access/egress moved to Purchase Street -- preserves public arcade along Pearl, High, and Oliver Streets.

Scheme C

- o Introduction to "twin-tower", 4-building concept.

Scheme D

- o More articulation of 529 foot twin towers in Phase I.
- o Base reduced to 5 floors.

Scheme E

- o Phase I tower height is reduced to 490 feet.
- o Phase IB massing changed to horizontal expression.

Scheme F

- o Phase I building height reduced to 437 feet.
- o Existing fire station to remain.
- o Existing structures at Purchase and Oliver retained and renovated.
- o Phase II program reduced to 400,000 SF.

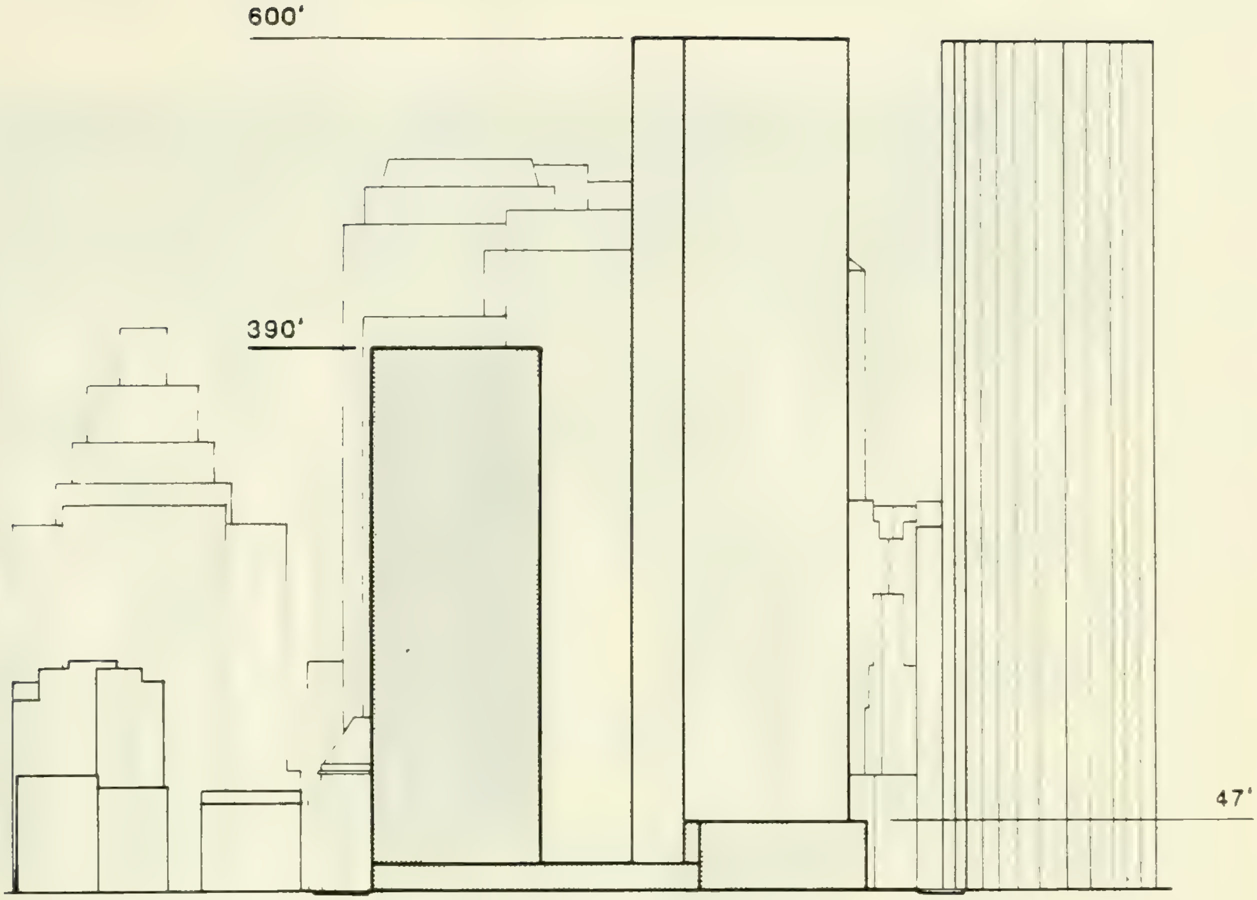
Scheme G Schematic Design Submission.
(See Project Description).

- o Fire station relocated to Purchase Street.
- o Garage access on Purchase Street.

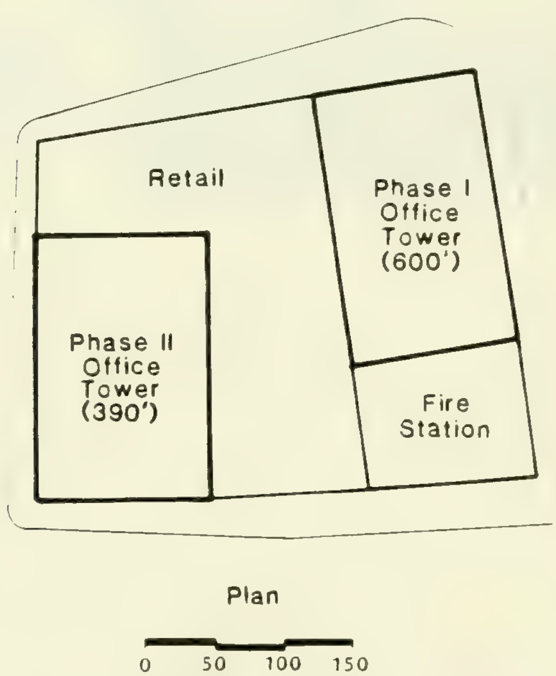
- Oliver Street building redesigned to lower overall height to 21 floors.

- Redesign of infill base to admit more natural light to spaces accessible to the public.

The alternative schemes as well as the program elements are illustrated in Figures 4-31 through 4-44, immediately following. The next section discusses each of these alternatives in detail.



Elevation



Plan

FIGURE 4-31 ELEVATION AND PLAN OF PROGRAM ELEMENTS

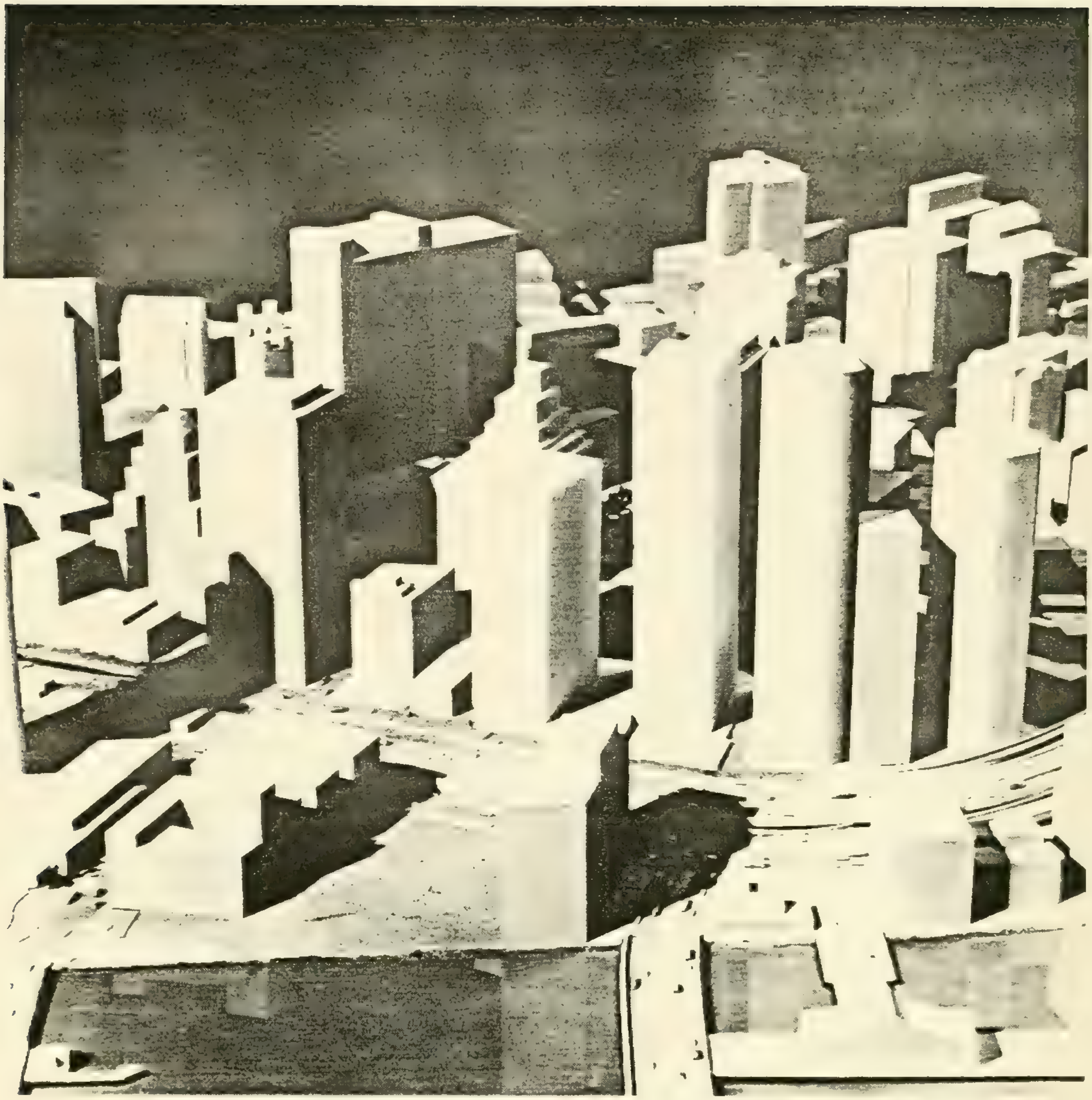
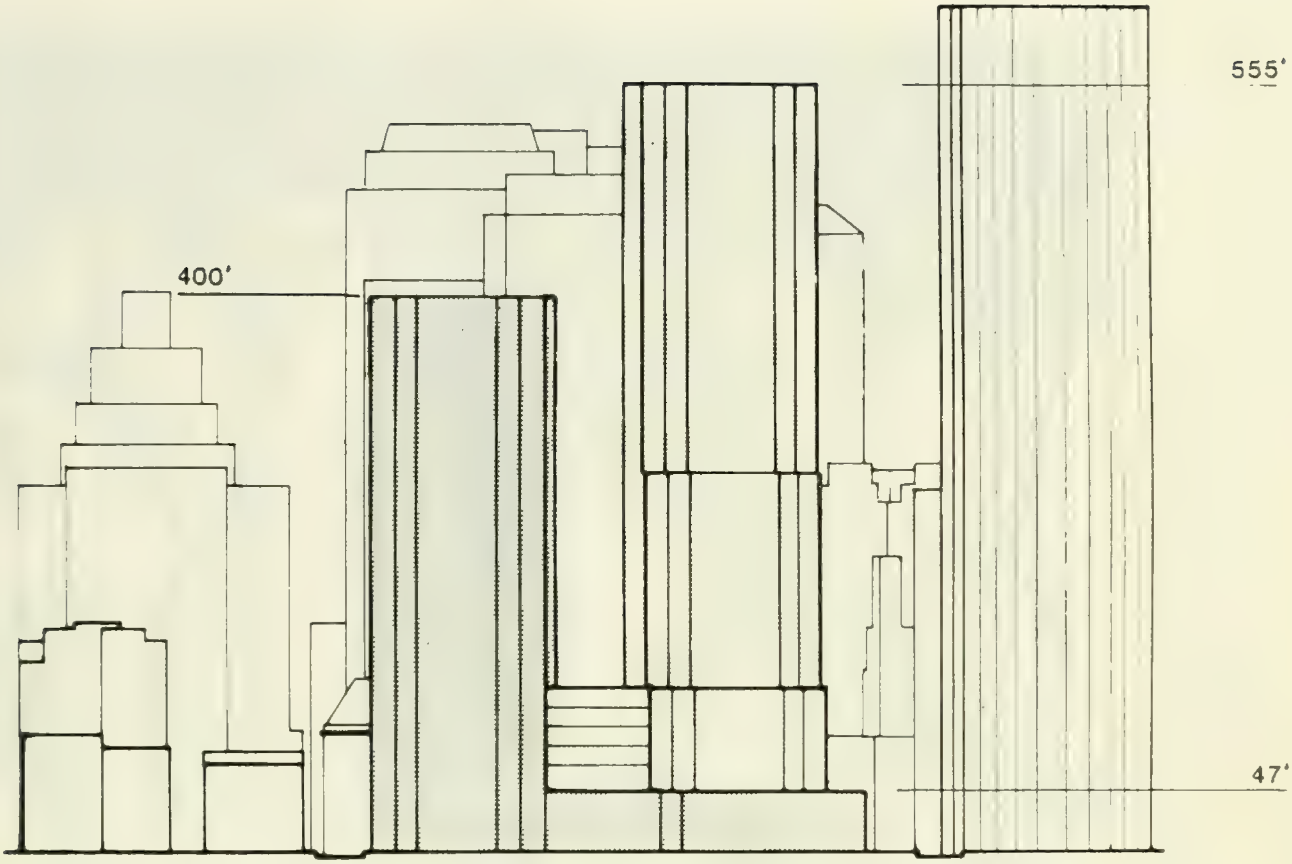


FIGURE 4-32 PROGRAM ELEMENTS



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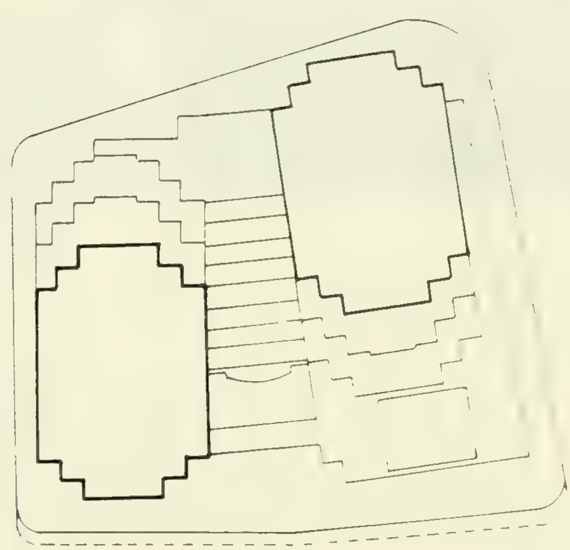

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FIGURE 4-33 ELEVATION AND PLAN OF SCHEME A

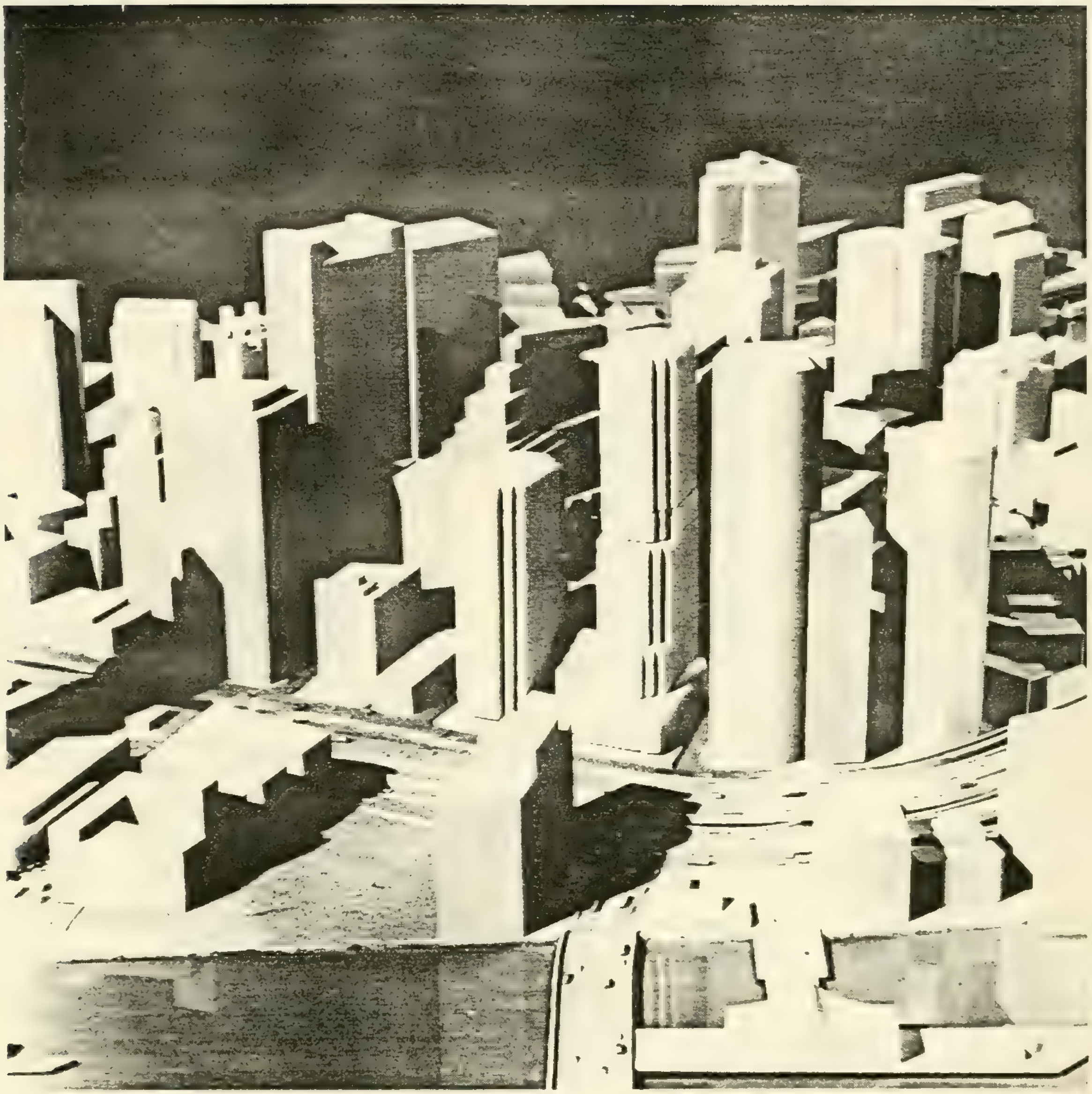
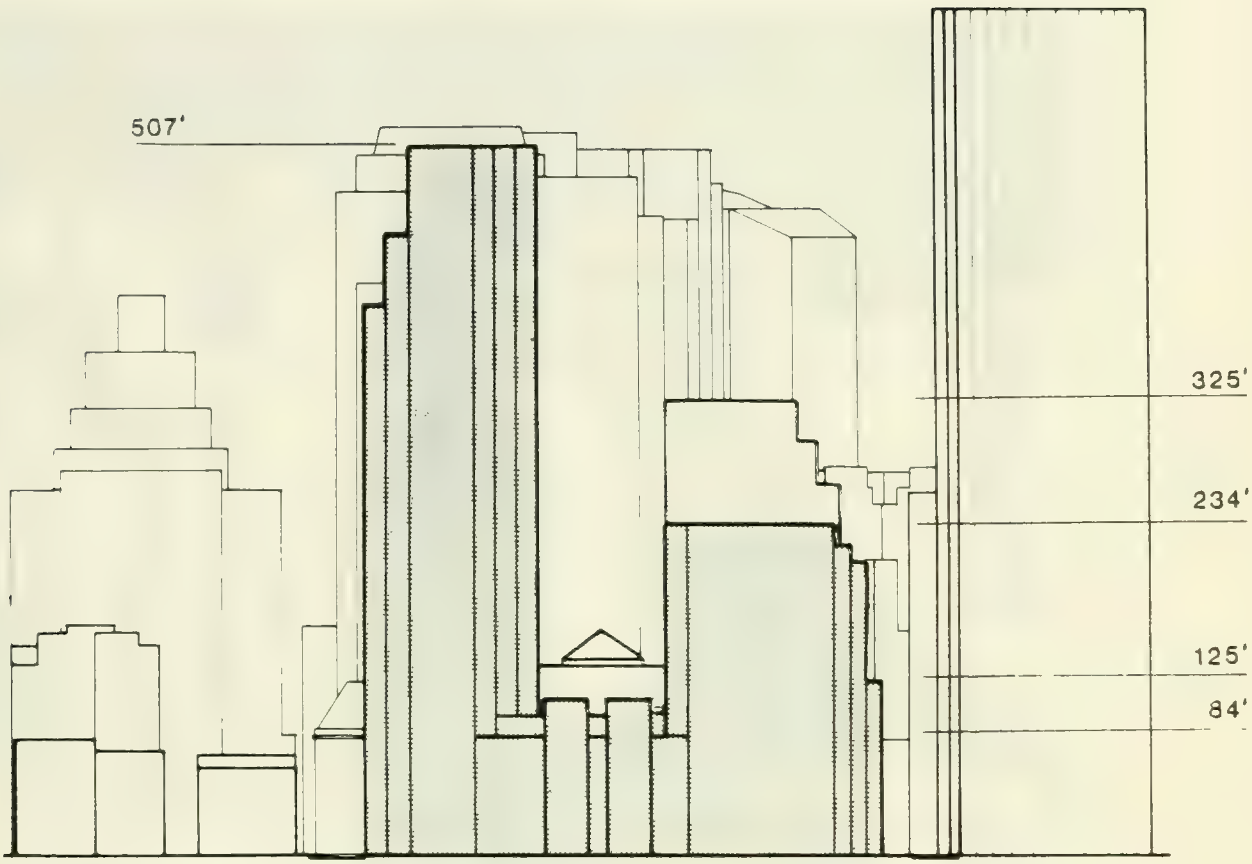


FIGURE 4-34 SCHEME A



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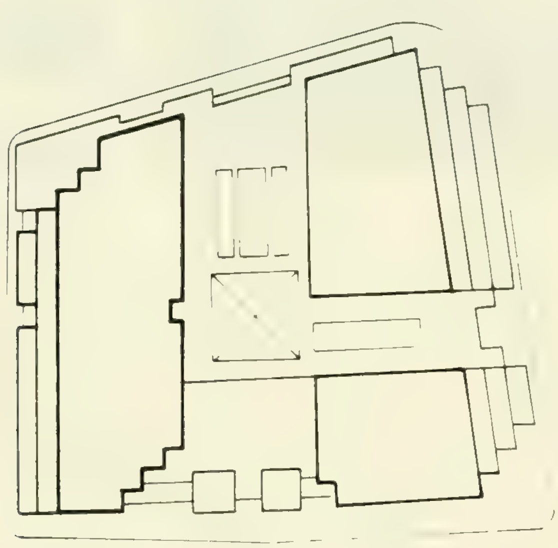

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FIGURE 4-35 ELEVATION AND PLAN OF SCHEME B

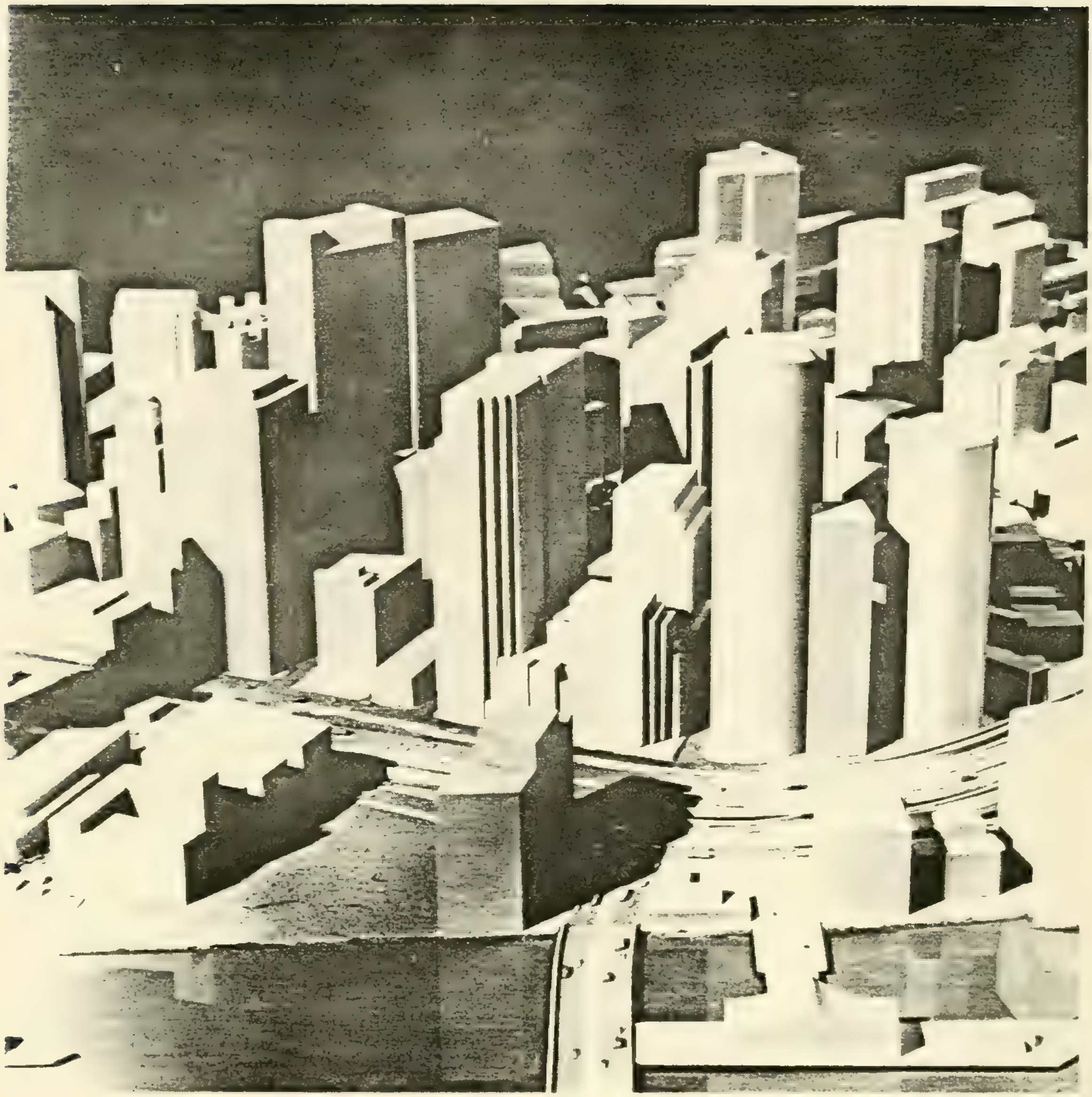
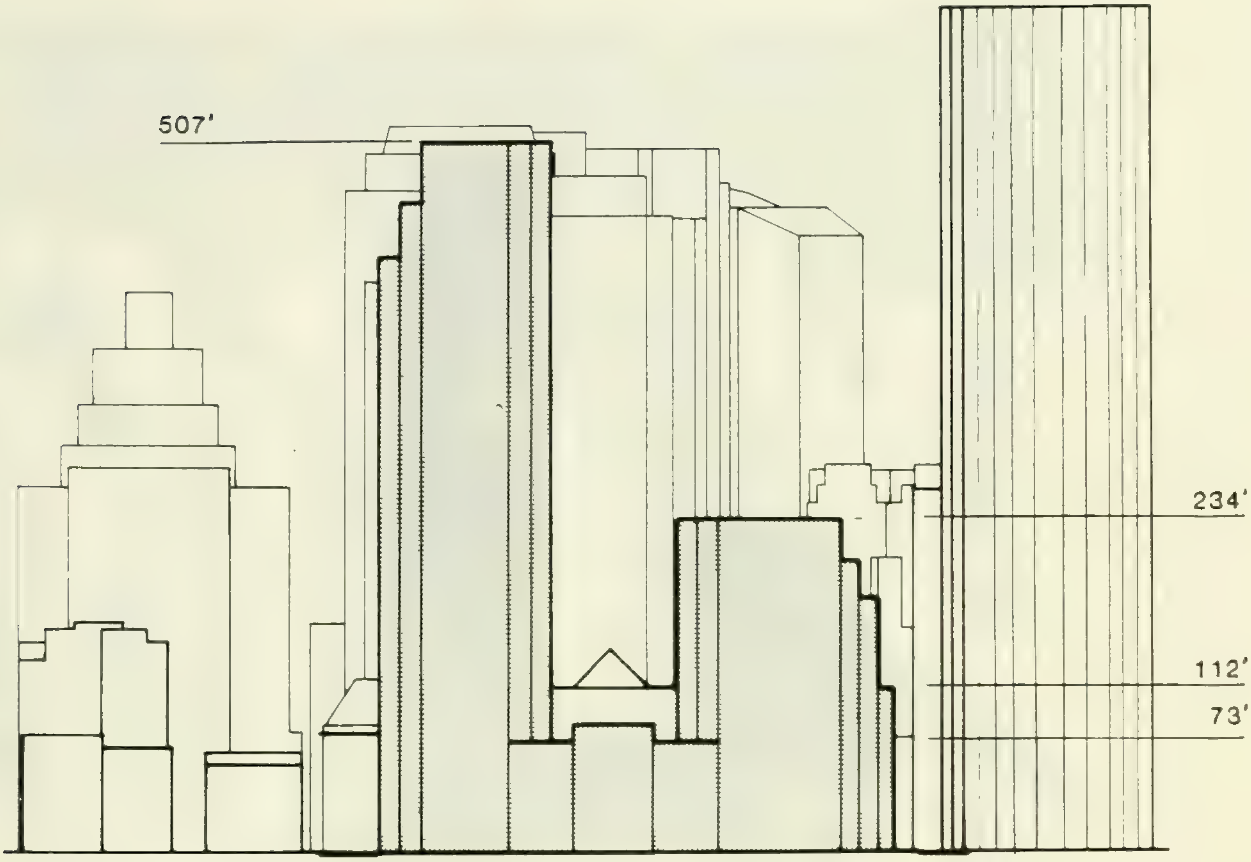


FIGURE 4-36 SCHEME B



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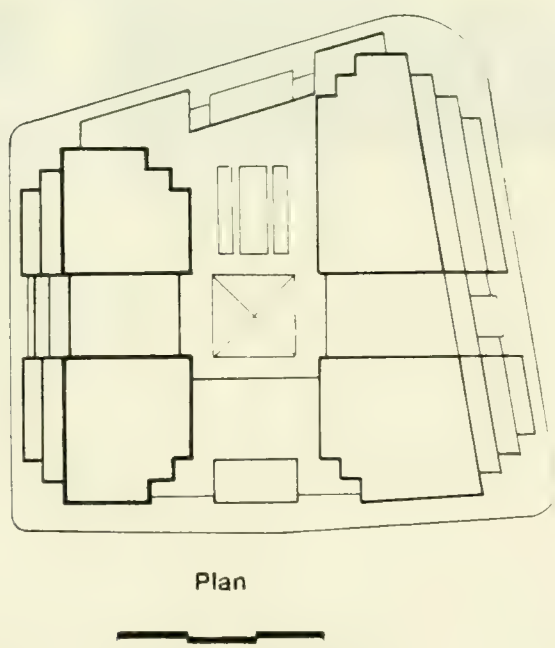
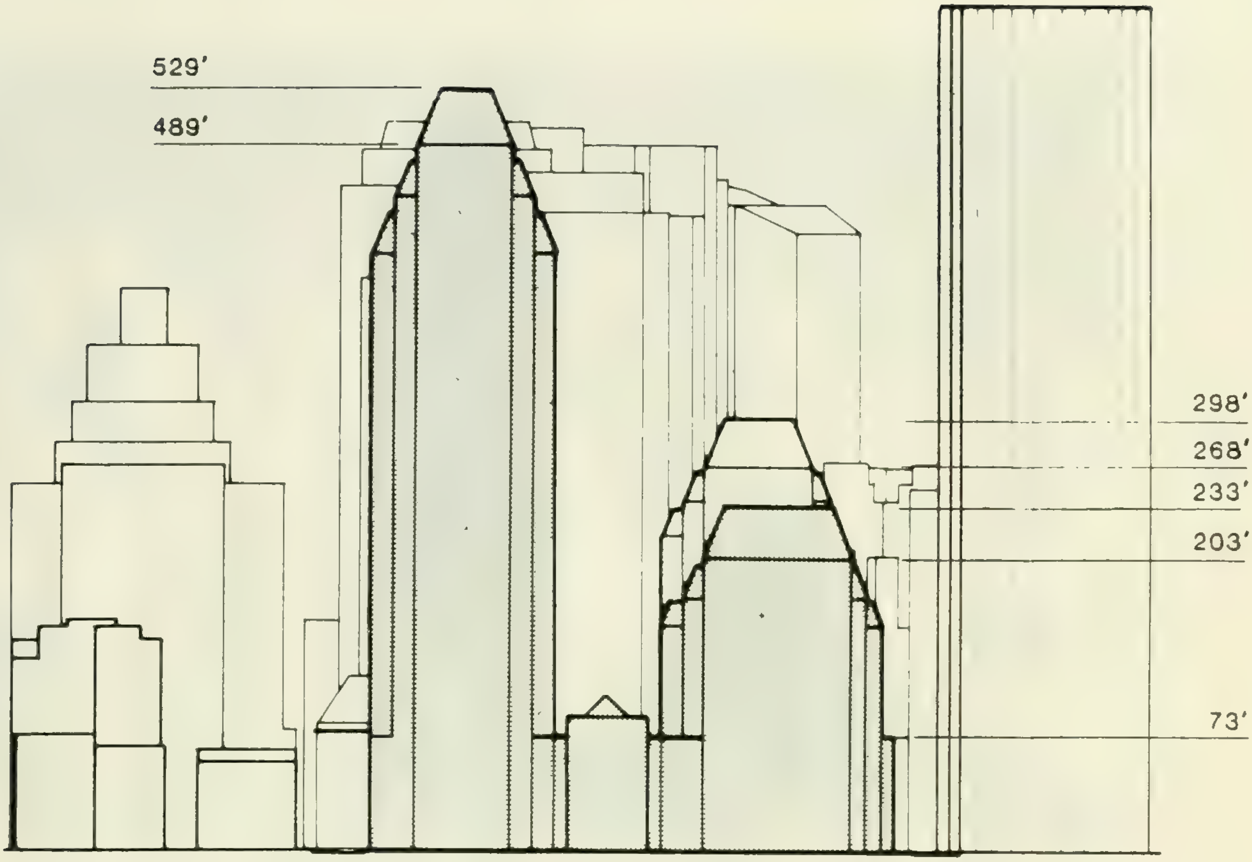


Plan

FIGURE 4-37 ELEVATION AND PLAN OF SCHEME C

FIGURE 4-38 SCHEME C



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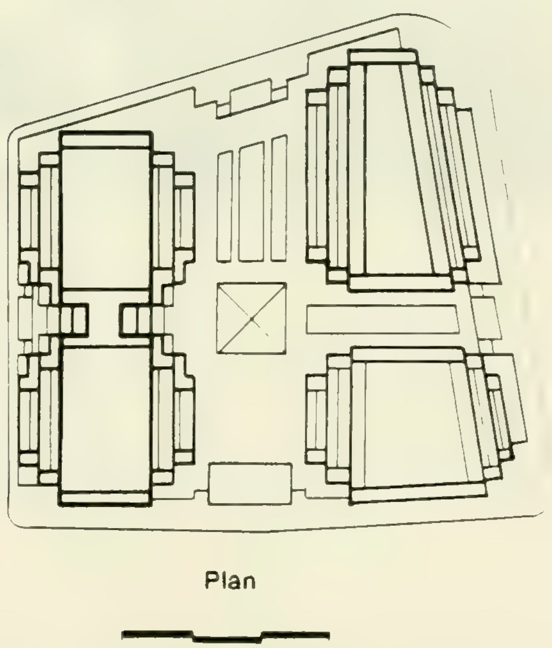


Plan

FIGURE 4-39 ELEVATION AND PLAN OF SCHEME D

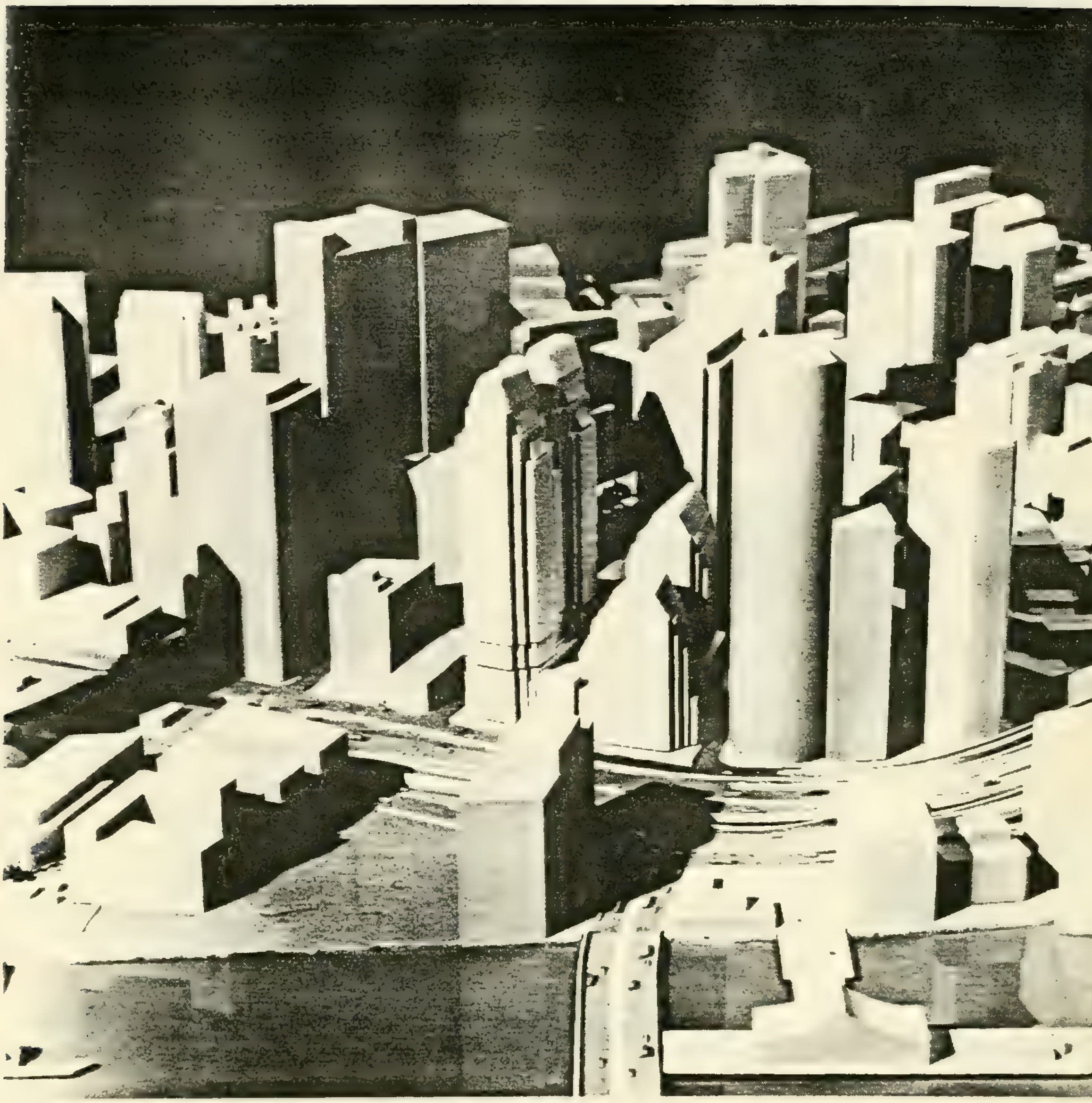
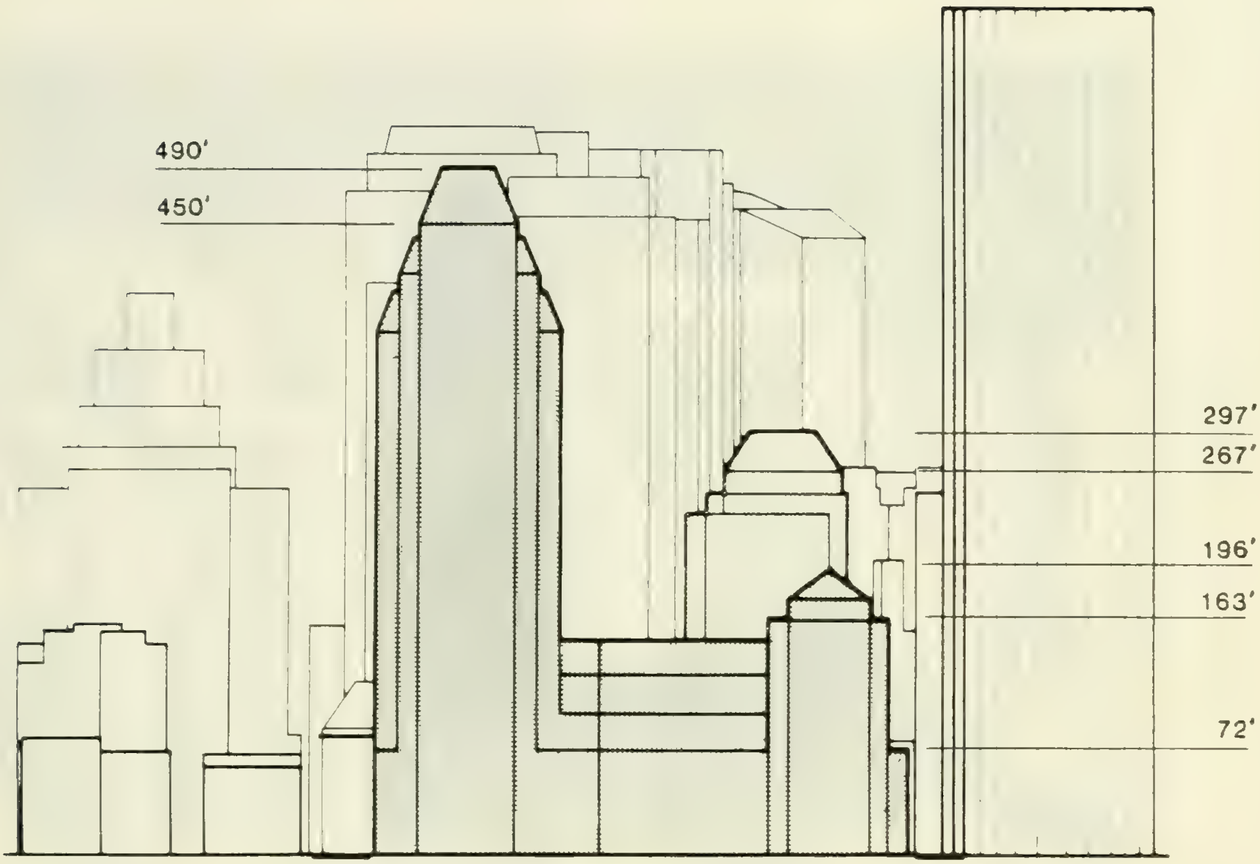
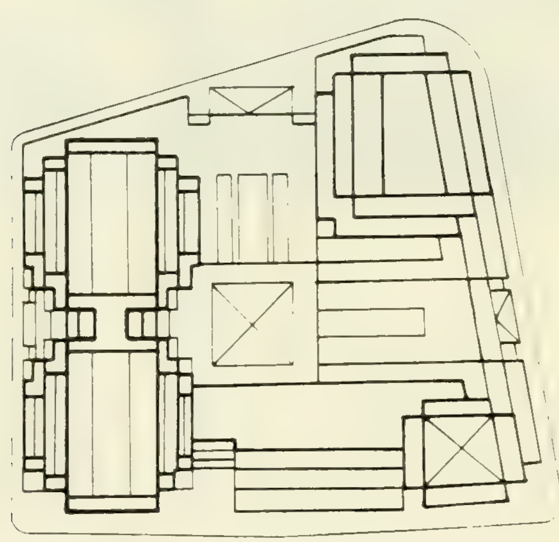


FIGURE 4-40 SCHEME D



Elevation



Plan

FIGURE 4-41 ELEVATION AND PLAN OF SCHEME E

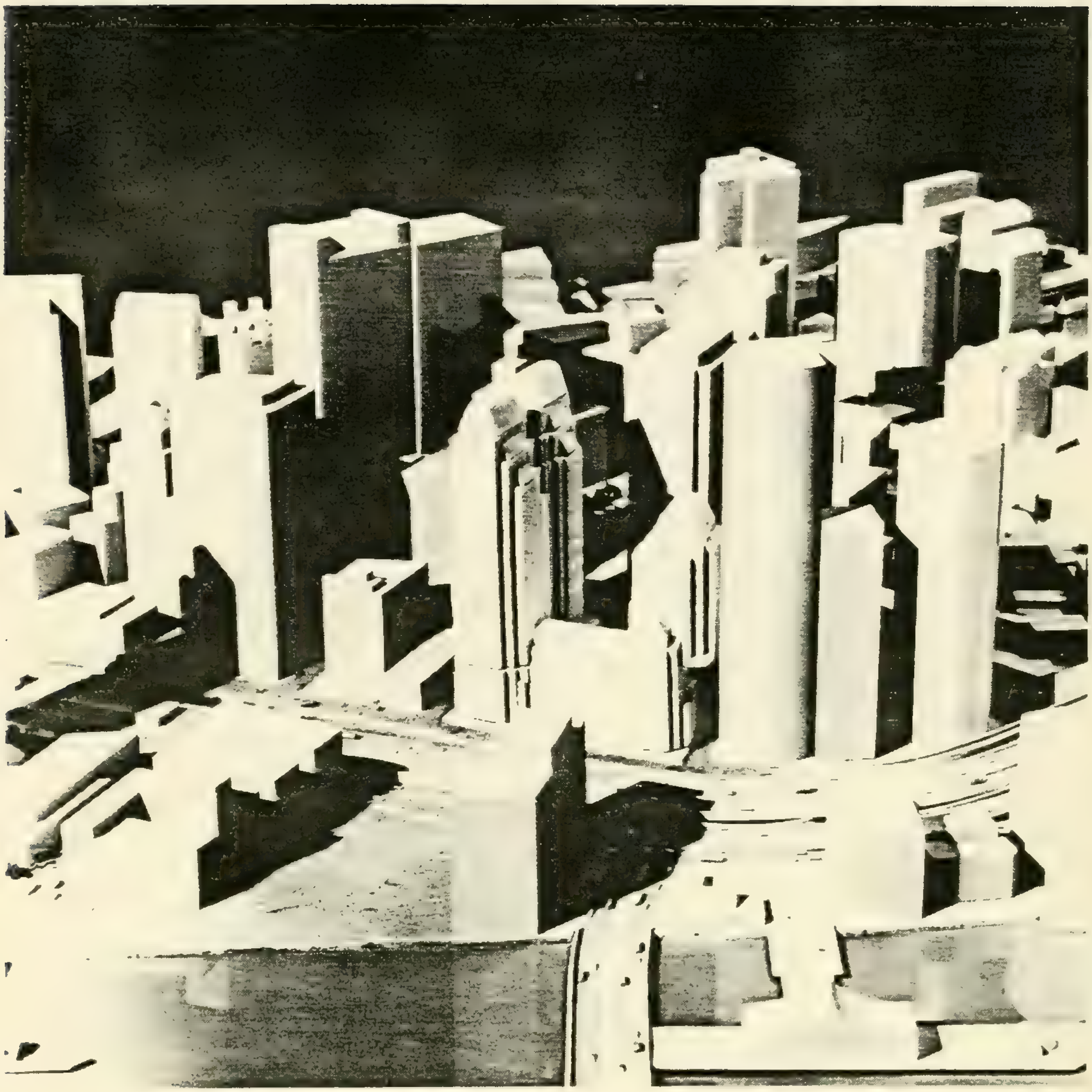
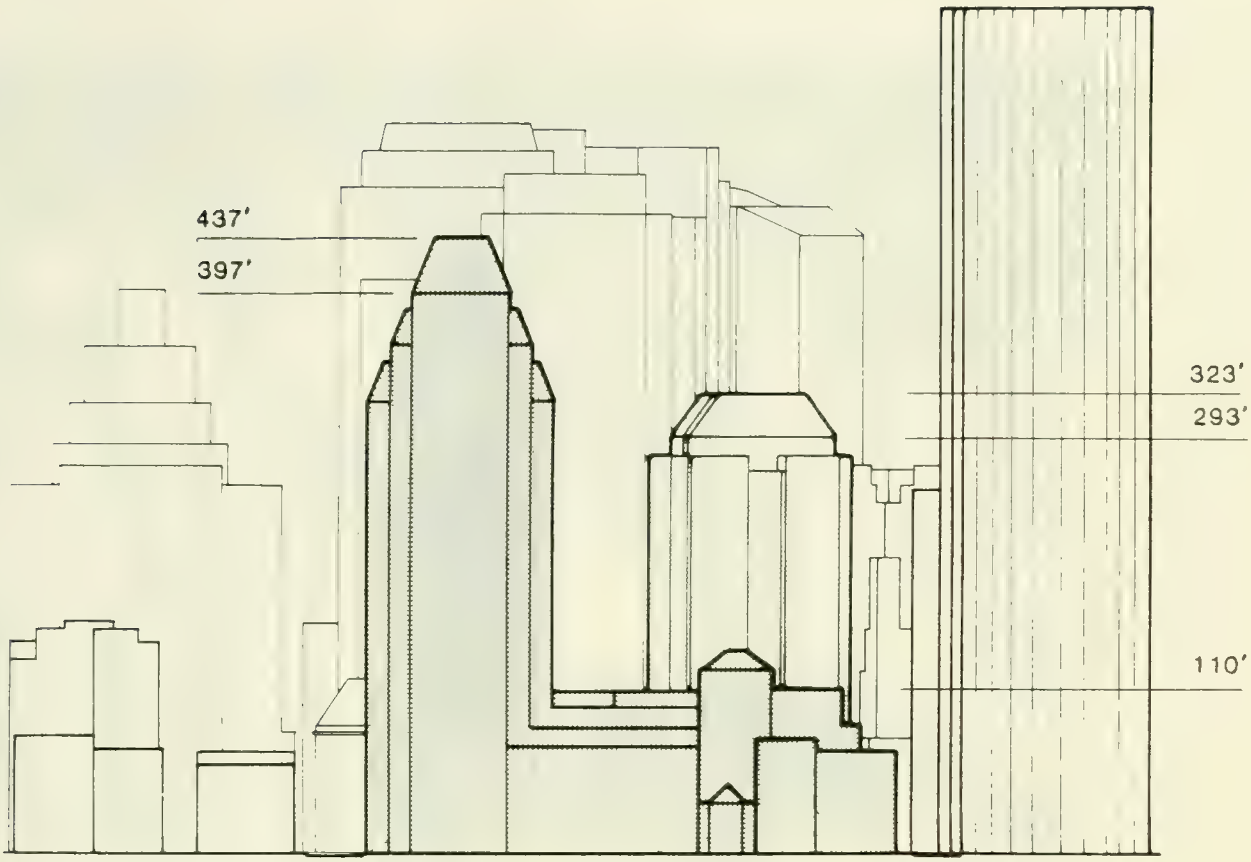


FIGURE 4-42 SCHEME E



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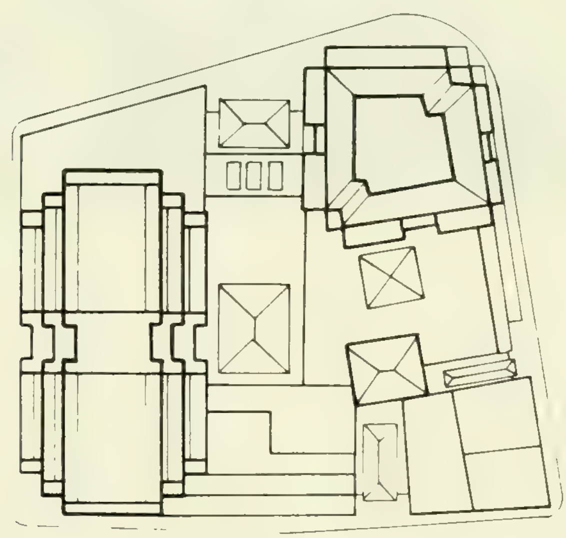

Plan

FIGURE 4-43 ELEVATION AND PLAN OF SCHEME F

FIGURE 4-44 SCHEME F

4.8 Discussion of Design Alternatives

Design concepts considered the following conceptual alternatives:

- Keep existing fire station vs. relocating it on-site.

- "Open" courtyard vs. "closed" atrium.

- Single highrise vs. twin highrises.

- Keep and renovate the 19th century buildings vs. demolition of 19th century buildings.

- Keep existing Traveler's Building vs. demolition.

In addition to these alternatives, design concepts have also included issues of scale and massing; aesthetic considerations; functional optimization of space for tenant use; renovation of older buildings; streetscape; public and private spaces; and parking and traffic. While other projects of similar scale have faced similar issues, One Twenty Five High Street also had the unusual aspect of incorporating an existing Boston Fire Station and the need to keep the facility operating throughout the construction phase. Achieving a balance of design considerations, optimizing benefits to the public and minimizing adverse environmental impacts have been major goals through the conceptual design phase of this development. This has been achieved in large measure by the reduction of the massing and scale, and reconfiguration of building elements through an iterative review process with the BRA. As each scheme was presented informally to the BRA, comments on specific project elements, overall massing and scale, and other urban design considerations, were forwarded back to the developer. The comments were then incorporated into project design, a new scheme developed, and a new informal submission made to the BRA. This

process continued through the seven schemes presented herein, resulting in the proposed project plan.

The earliest concept for One Twenty Five High Street began with issues of scale and massing. Prior to developing the first schemes, the conceptual program included a 600 foot tower at the corner of Oliver and High Streets and a 390 foot building at the corner of Pearl and Purchase Streets (Figures 4-31 and 4-32). This concept was carried into the first scheme although the Phase I Tower was reduced from an initial height of 600 feet. Scheme A (Figure 4-33) called for a 555 foot tower at the corner of Oliver and High Streets and a second highrise at the corner of Pearl and Purchase Streets. This would have given the owners the opportunity to leave the Travelers Building in place throughout the construction of the first tower. It would have also called for the demolition of the 19th century buildings and relocation of the fire station to Purchase Street. Furthermore, this scheme required access and egress along Oliver Street, which is narrow and congested. While this approach would have been financially beneficial to the owners, there were several disadvantages to the scheme. First, it would have created a "canyon" effect by placing a new tower close to International Place. Moreover, Oliver Street is a narrow street, thereby contributing to undesirable traffic impacts. This scheme was not acceptable to the BRA in that the tower was too tall, and too close to International Place.

In response, Scheme B (Figure 4-35) was proposed. In Scheme B, the tower was lowered to 507 feet and shifted to Pearl Street, putting distance between the new building and International Place. However, this second scheme required the demolition of the Travelers Building prior to any new construction. With the owners committing to demolition of the Travelers Building at the beginning of construction, this scheme offered more flexibility; it opened up the possibilities of twin towers that could "break up" the massing and it allowed the architects to shift the access/egress point to Purchase Street rather than Oliver Street. This is a significant mitigation of traffic problems because Purchase Street is a service road to the Central Artery

and is better able to handle traffic than Oliver Street. Finally, the opening up of the site by removing the Travelers Building and shifting the garage entrance to Purchase Street provided the opportunity for pedestrian access along three sides, on Pearl, High, and Oliver Streets. In terms of the fire station, Scheme A called for its relocation to Purchase Street and Scheme B required it to be kept on Oliver Street. While Scheme B had advantages over Scheme A, the BRA was still concerned over height and massing. The next three schemes began to reduce the height and introduce articulation to the buildings to reduce apparent mass.

Scheme C (Figure 4-37) introduced a "twin tower", four building concept. This had the effect of breaking up the mass and giving more shape to the buildings. Scheme D (Figure 4-39) further refined the mass with greater articulation but the buildings were still in excess of 500 feet tall. Scheme E (Figure 4-41) reduced the height of the main building to 490 feet and lengthened the base of the second building to reduce its apparent mass.

There was a further reduction in the height of the tallest building to 437 feet under Scheme F (Figure 4-43) which also called for leaving the fire station on Oliver Street. This interrupted the continuity of the buildings along Oliver Street and required a narrow base for the second building.

By re-introducing the concept of relocating the fire station to Purchase Street in order to improve the egress for emergency vehicles, a concept first suggested in Scheme A earlier, the final preferred alternative emerged. The lengthening of the base of the 21-story building presented the opportunity for greater horizontal expression and continuity to reduce its apparent mass.

This evolutionary process resulted in several mitigating factors that minimize adverse environmental impacts and increase the benefits of One Twenty Five High Street. These are as follows:

- Reduction of "canyon" effect on Oliver Street.

- Main building fronting on Pearl Street.

- Tallest building height reduced from 600 feet to 400 feet.

- Placement of garage entrance at Purchase Street, instead of Oliver Street (which is better able to handle project-related traffic), and relocation of fire station to Purchase Street.

- Opportunity for pedestrian access on three sides of the complex: High Street, Pearl Street, and Oliver Street.

- Apparent mass reduced with articulation on both main buildings.

- Inclusion of a publicly accessible atrium and street level retail.

- Improved egress for fire station.

- Smaller 21-story building compatible with historic streetscape.

- Retention and renovation of three 19th century buildings.

In summary, the preferred alternative design of One Twenty Five High Street evolved out of a fifteen month iterative review process that was sensitive to design, aesthetics, environmental impact, and scale. The product that emerged is one that was given a great amount of thought and consideration, resulting in a careful balance of design issues to provide a development where both public and private benefits can be optimized.

5.0 PROJECT AREA DESCRIPTION

5.0 PROJECT AREA DESCRIPTION

One Twenty Five High Street encompasses the entire city block bounded by High Street, Pearl Street, Purchase Street, and Oliver Street. The project area is within Boston's Financial District and overlooks the Fort Point Channel area. The site is separated from the Fort Point Channel area by the Central Artery, although a footbridge immediately across the street from the site connects Purchase Street to Atlantic Avenue. This part of the Financial District and the Fort Point Channel area have been characterized by intense redevelopment, both by private and public projects, several of which are under construction and others which are in the planning stages.

Historically, the area has gone through many changes. During the early 19th century, this block and adjacent blocks in the Fort Hill area comprised a fashionable residential area. By the 1850's, this once affluent residential area began to feel the effects of Boston's burgeoning economy. Business merchants moved their establishments into the area and dismantled private homes in favor of granite row buildings. These businesses flourished in this busy mercantile hub until it was destroyed by the Great Fire of 1872. The fire was so extensive that the buildings in this section of Fort Hill were levelled. New construction was well on its way by the 1880's when four- and five-story masonry and stone buildings replaced the former structures.

Three of the post-fire structures exist today at the corner of Purchase Street and Oliver Street. These represent stand-alone vestiges of the 1880's rebuilding. The demolition of buildings to make way for adjacent developments removed the possibility of connecting this area to a designated historic district.

The growth of Boston's downtown has made it one of the premier financial and service centers in the nation. Activities in the various intensive growth periods, punctuated with periods of slump and decay (such as the late 60's and early 70's), has brought the downtown to its current level of intense development and redevelopment.

In the immediate vicinity of the project site are several significant new projects under construction. These are:

- International Place -- A 1.6± million SF office and retail complex. The project will include: a 46-story, 600 foot cylindrical tower; a proposed 35-story, 460 foot cylindrical tower; a 19-story mid-rise along Oliver Street (which faces the One Twenty Five High Street project); a proposed 11-story building facing High Street; and a 25,000 SF public area which will contain retail establishments and restaurants. The exterior skin is granite and glass.

- Rowes Wharf -- Located across the Central Artery within the waterfront district, a mixed-use development that includes housing, office, hotel, and restaurant and retail establishments.

- 265 Franklin Street -- A 16-story, 182 foot office building comprising 360,000 SF (completed in 1984).

While these three projects are within sight of One Twenty Five High Street, a number of other buildings were either constructed, under construction, or are planned for in this general area of the financial district. These are:

- 99 Summer Street
- 75 State Street
- 260 Franklin Street

- One Post Office Square
- One Financial Center
- 125 Summer Street
- 101 Federal Street
- United Shoe and Machinery Building Renovation and Addition

Existing conditions on the site include the 16-story Travelers Building. Built in 1958, the structure is positioned with considerable setbacks for surface parking. It restricts any development on the western half of the block without alteration of the building. Moreover, the existence of the City fire station at the eastern side of the block further restricts utilization of the land for development. While such underutilization of the land may have been acceptable in the 1950's, it represents only about half the potential floor area ratio (FAR) of the site. At about 358,000 SF, it is about 5.5 FAR as opposed to the 10 FAR allowed by the Zoning Code.

The higher density utilization is not only evident in the newer structures noted above, but also in nearby existing buildings such as the State Street Bank Building, New England Telephone Building and the Keystone Building. Figures 5-1 and 5-2 depict aerial photographs of the site indicating the taller buildings in the vicinity of the Travelers Building.

Transportation

The existing transportation system serving the site is well developed, consisting of regional highways, an arterial street system, parking facilities and public transportation lines, including bus, rail, and commuter boat services. The primary regional highway serving the site is the Central Artery (I-93), which passes through the downtown core and links the Southeast Expressway and Massachusetts Turnpike (I-90) on the south with I-95 and the harbor tunnels to the north. Off-ramps are provided to High Street for both northbound and southbound traffic, while on-ramps are provided from Congress Street.

FIGURE 5-1 AERIAL PHOTOGRAPH OF EXISTING SITE CONDITIONS

FIGURE 5-2 AERIAL PHOTOGRAPH OF EXISTING SITE CONDITIONS

The local street system serving the site forms a grid with Purchase Street and High Street, both one-way westbound, Pearl Street one-way northbound, and Oliver Street one-way south-bound.

Traffic flows on the streets surrounding the site include approximately 600 vehicle trips to the project site (average daily traffic) and an estimated 15,000 vehicle trips past the project site on Purchase Street.

High Street and Purchase Street carry comparable volumes during the morning commuter peak period. During the afternoon peak period however, Purchase Street, which functions as a frontage road to the Central Artery, carries substantially heavier volumes than does High Street. Pearl and Oliver Streets are much less intensively used. Congress Street, one block west of the site, is a major egress corridor from the Financial District, carrying heavy evening peak flows.

Parking

The parking system in downtown Boston is beginning to feel the strain resulting from increased demand from new development with little or no expansion in the public parking supply. Of the nearly 7,500 public parking spaces within 1,500 feet of the site, 90 percent are occupied by noontime on a typical day, according to a 1982 City study.

Recognizing the potential space shortage, the City has begun to plan some improvements and supply increases. Notable examples are the planned Post Office Square Garage and a new 2,500-space facility at South Station. Even with these improvements, however, parking will likely remain in short supply in the Financial District.

Given the location, the proposal to provide approximately 850 below grade parking spaces as part of One Twenty Five High Street will particularly benefit motorists who exit the Central Artery at High Street. Instead of weaving through local streets, these motorists will be able to reach the One Twenty Five High Street parking garage.

Public Transportation

The site is well served by public transportation. Three of the four MBTA subway lines (Orange, Red, and Blue) have stations within 2,000 feet of the site. The fourth line (Green) is approximately 2,500 feet away.

In addition to the subway lines, the terminals of the commuter rail lines serving the southern and western suburbs, as well as the Amtrak main line serving the Northeast Corrider, are located at South Station, which is about 1,500 feet from the site, and the terminus of the MBTA's express bus service to the western suburbs is located only two blocks west of the site. Finally, a new commuter boat docking facility is operating at the Rowes Wharf Development project approximately 1,000 feet east of the site.

Pedestrian Circulation

The pedestrian pathways which will be used by the project tenants are a function of downtown activity centers, parking facilities and transit stations. There are five major centers of activity which will generate or attract significant pedestrian activity to or from the site. These include:

- Government Center/Faneuil Hall Market area
- Downtown Crossing
- South Station
- Northern Avenue/Fort Point Channel
- Rowes Wharf/Waterfront area

The heaviest activity during the commuting hours will be noticed on pathways between the site and the South Station and Northern Avenue/Rowes Wharf areas by nature of their use as major transportation terminals/parking facilities. Streets and footbridges most likely to be used by pedestrians will include:

- Atlantic Avenue adjacent to the Federal Reserve Building
- Congress Street
- Purchase Street
- High Street
- The pedestrian bridge over the Central Artery

During the non-commuter periods, particularly noontime, the orientation of pedestrian activity will likely shift toward the Downtown Crossing and Faneuil Hall Market Place activity centers as project tenants conduct their personal business. The most heavily used streets for this purpose will likely be High Street and Franklin Street, north of the site, and Pearl/Congress Streets, west of the site.

Pedestrian traffic between transportation terminals and final destination offers the most likely source of through-pedestrian activity. These linkages include the pathways between Northern Avenue/Fort Point Channel and the Financial District, and South Station and the Broad Street area.

The physical condition of most of the pedestrian pathways in downtown is good, with adequate sidewalk width and crossing controls in most instances. One marginal pathway is the connection between the site and Northern Avenue, which involves crossing the Central Artery on a pedestrian footbridge.

One Twenty Five High Street is consistent with recent development trends in the Fort Hill area and its design, uses, and public amenities are consistent with City goals and policies for the area. A currently under-utilized site in the midst of new construction and redevelopment will be transformed into a well-designed and appropriately proportioned office complex with mixed uses at street level and inviting pedestrian arcades, shops, and interior landscaped spaces for the benefit of pedestrians.

6.0 ENVIRONMENTAL IMPACT ANALYSES

6.1 TRANSPORTATION IMPACTS/ACCESS PLAN

6.1.1 Introduction

This section of the Environmental Assessment describes existing transportation conditions in the project study area, estimates the impact of the development in terms of vehicle, transit and pedestrian trips to the site, and provides an analysis of the study area under existing and future (1994) conditions. As a benchmark, it provides an analysis of conditions in the forecast year without One Twenty Five High Street but with other projects currently under construction or approved for development. The work described herein is based on the scope issued by the Boston Redevelopment Authority, a copy of which appears in Section 3.2 above.

6.1.1.1 Summary of Findings

On a daily basis, the project is expected to generate 1,255 net new one-way vehicle trips (i.e., total project trips less existing trips). During the peak hours, an estimated 436 and 445 new trips are projected during the inbound AM and outbound PM peaks, respectively. Seventeen intersections were analyzed with regard to traffic impacts. The addition of project-related traffic to 1994 No-Build volumes results in only one location that is projected to experience a change in peak hour Level of Service (LOS) from No-Build conditions. That intersection is at Oliver Street/Purchase Street which will decline from LOS "B" to LOS "C" in the morning peak hour and from LOS "A" to LOS "B" in the evening peak hour. Levels of service can range from LOS "A" to LOS "F"; LOS "B" and "C" are considered acceptable levels of service. Volume-to-capacity ratios and delay values increase at six other locations while not changing level of service.

Between 1986 and 1994, rapid transit use on the seven line segments is expected to increase by an average of almost 37 percent based on background development growth. The project will add a further increase of almost 2 percent. With the MBTA now in the final stages of improvements on both the Orange and Red Lines, an expansion from four-car to six-car trains is anticipated prior to 1994 on both lines. This, coupled with new equipment on the Green Line, will result in a substantial increase in transit capacity on those lines. However, under both No-Build and Build conditions, the Blue Line north, Orange Line north, and Green Line west will be over line capacity in 1994. All other lines will operate below capacity.

One Twenty Five High Street will include the construction of below-grade parking which is proposed to contain approximately 850 spaces, of which approximately 150 will be designated for public use, 30 for the Boston Fire Department and seven for the Boston ambulance facility. The analysis suggests that the long-term commuter parking demand associated with the project will be 1,015 spaces. Short-term, non-employee demand is expected to be 265 spaces at peak. This demand estimate may be somewhat high, as it is based on a conservative projection of mass transit use which is below that experienced at some buildings in the Financial District.

The EIA includes a proposed Access Plan which identifies actions to reduce further the impact of development. Included in the Access Plan are commitments by the proponent to take steps to reduce and better manage vehicular trip generation to the site and to design access to the building in order to minimize impacts on adjacent streets. Trip reduction efforts include measures to promote ridesharing and transit use, to encourage alternative work schedules, to restrict truck deliveries to non-peak hours, and to provide administrative support for trip reduction/management efforts.

6.1.1.2 The One Twenty Five High Street Project

The development program analyzed consists of approximately 1,400,000 square feet of office and retail development. Although the final development program may differ slightly from the size analyzed, this will have no impact on the results of the transportation analysis. Table 6.1-1 summarizes the development program analyzed, which includes 1,356,000 square feet of office space and 34,000 square feet of retail space. The site encompasses the entire block bounded by Purchase Street, High Street, Oliver Street, and Pearl Street. Currently, the existing 16-story Travelers building occupies most of the site along with the Fort Hill Fire Station and three low-rise buildings. As a result, the project will add almost 1,000,000 square feet of new space to the Downtown office market.

TABLE 6.1-1
ANALYSIS DEVELOPMENT PROGRAM

Use	Size (square feet)
Office	1,356,000
Retail	34,000
Total	1,390,000
Parking spaces (below grade)	850

6.1.1.3 Study Area

The study area defined for this project includes 17 intersections within a perimeter bounded by Atlantic Avenue to the east; Broad Street to the north; Franklin Street to the west; and Summer Street and Federal Street to the south. The site location and 17 analysis locations are illustrated in Figure 6.1-1.

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Site Location and Study Intersections

SCALE: 1"=Approx. 6

LEGEND:

◯ Intersection Study Location

Fig. 6.1-1

1602/487/wpr

Public transportation in the area of the project is well developed and utilized. Three of the MBTA's four subway lines are directly accessed at stations within 2,000 feet of the site, the closest being South Station (Red Line) and State Street (Orange and Blue Lines). Commuter rail service from South Station, commuter boats, and express buses to the south and west are also accessible within 2,000 feet of the site.

6.1.1.4 Study Methodology

The transportation study was conducted in three distinct phases. Phase I involved an inventory of existing conditions and travel demand characteristics in the area. The inventory included researching previous transportation reports as well as conducting new observations. Observations of traffic volumes were conducted during the morning and evening peak periods at key intersections serving the site. These counts included pedestrian crossing and sidewalk volumes. In addition, transit line performance and ridership were assessed.

Phase II of the study built upon the data base in Phase I and established the framework for evaluating the transportation impacts of the proposed project. In this phase, travel demand forecasts for the project were assessed along with forecasted demands created by other future area developments approved or under construction. Estimates were made for all transportation modes. An analysis year of 1994 was established based on projected occupancy of the proposed development.

Phase III, the final study phase, included evaluation of the impacts of the project on the transportation and pedestrian system and identification of measures to mitigate any adverse impacts. Included within this effort was the development of an Access Plan for One Twenty Five High Street.

6.1.2 Existing Conditions

6.1.2.1 Roadway Network

Roadways in the area which will provide access to the immediate site include Purchase Street, Pearl Street, High Street and Oliver Street. Access to and from the regional highway system (Central Artery) is provided by the Surface Artery, Purchase Street and Atlantic Avenue. Figure 6.1-2 illustrates the roadway circulation pattern now existing in the area. The following provides a brief summary of roadway characteristics:

- Central Artery - a major north/south highway east and south of the site with connections to the Southeast Expressway, the Massachusetts Turnpike and major routes north. It is a divided roadway providing three travel lanes in each direction.

- Surface Artery - a major north/south arterial surface street east and south of the site. Between Kneeland and Summer Streets, it provides three travel lanes in each direction above the Central Artery. North of High Street, it runs below the elevated artery, providing two travel lanes in each direction.

- Summer Street - a major east/west arterial linking the Downtown Crossing area to Dewey Square and to South Boston across the Fort Point Channel. The number of lanes varies from one to three in each direction with no parking on either side.

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Study Area Circulation

LEGEND:

Site

← Direction Of Travel

SCALE: 1"=Approx. 670'

Fig. 6.1–2

- Atlantic Avenue - a major north/south arterial which parallels the Central Artery and generally provides two to three lanes for one-way northbound traffic south of High Street. The road is two-way north of High Street. Parking is located along the eastern side of the Avenue from South Station to High Street.

- Purchase Street - a major one-way arterial paralleling the Central Artery which provides two to three lanes southbound to Summer Street from High Street.

- High Street - a major one-way connector providing two lanes southbound from the Central Artery to Summer Street. Two-way travel is permitted between Summer Street and Federal Street. No parking is allowed on the east side of the street while some parking is allowed on the west side of the street.

- Congress Street - a major east/west arterial linking the Government Center area to the Financial District and to South Boston across the Fort Point Channel. This street generally provides two to four lanes in the eastbound direction to Atlantic Avenue with no parking on either side.

- Pearl Street - a moderate volume one-way connector providing two lanes westbound from Purchase Street to the Post Office Square area. Some parking is allowed on both sides of the street.

- Oliver Street - a moderate volume one-way street providing two lanes eastbound from High Street to Purchase Street. It is one-way westbound west of High Street. No parking is allowed on either side of the street.

6.1.2.2 Existing Traffic Volumes

Estimates of existing peak hour traffic volumes are shown in Figures 6.1-3 and 6.1-4. A number of recent transportation impact reports were used as source material and several new turning movement counts were made in the study area in the process of developing these base networks. Reports which were referred to include the International Place FEIR, the Rowes Wharf FEIR, Dewey Square Transportation Systems Management (TSM) Study and the 125 Summer Street Draft Impact Study and Access Plan.

New turning movement counts were made at the following intersections: Summer Street/South Street/High Street, Congress Street/Franklin Street, Atlantic Avenue/Congress Street, High Street/Pearl Street, Pearl Street/Purchase Street, High Street/Oliver Street, and Purchase Street/Oliver Street. Review of these counts showed many traffic volumes in the immediate area to be low in comparison to other recent counts. This may be due in part to the several major construction projects now underway within or near the study area which are affecting normal traffic patterns. These construction projects include:

- o Dewey Square - Red Line station platform lengthening by the MBTA and utility construction;
- o South Station - Rehabilitation of the South Station head-house and development of the first phase of a multi-modal transportation center;
- o Summer Street at Washington Street - Red Line station platform lengthening by the MBTA;

- International Place - Construction of high-rise office and retail development between High Street, Purchase Street and Oliver Street, adjacent to the proposed One Twenty Five High Street site;

- Rowes Wharf - Construction of office, retail, residential and hotel development along Atlantic Avenue; and

- Construction and rehabilitation at a number of other sites in the area, including several former parking facilities (garages and lots) which are being replaced by new buildings and are no longer available for parking.

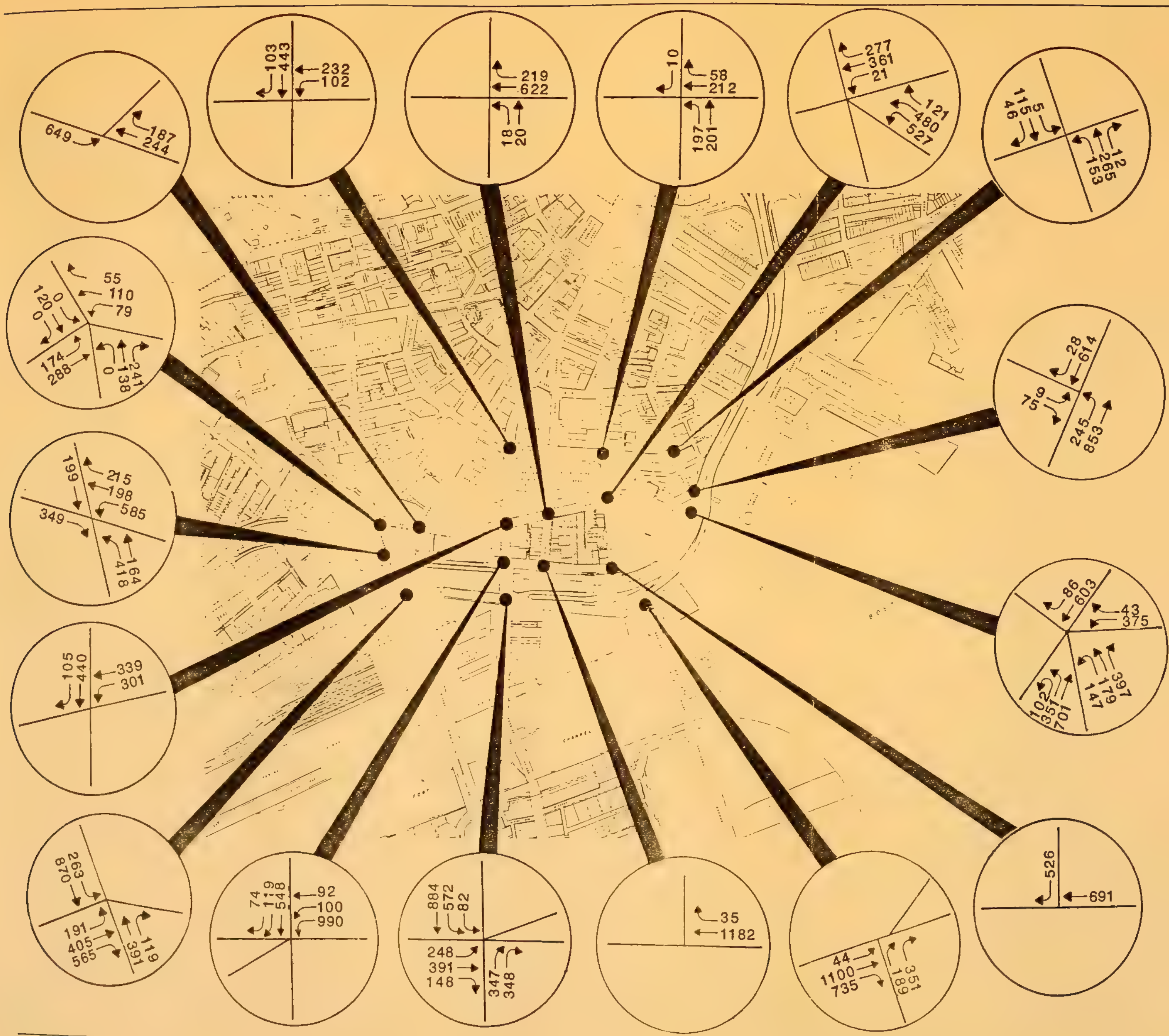
Therefore, in order to develop a network base indicative of normal preconstruction traffic patterns, it was decided to utilize the existing base volumes from the other impact reports previously mentioned. The entire traffic network was then balanced. The resulting One Twenty Five High Street network is consistent with the recent 125 Summer Street network, since large portions of the study areas of each project overlap.

6.1.2.3 Existing Pedestrian Volumes

Pedestrian crossing and sidewalk counts were conducted in the project area during September of 1986. These counts concentrated on the pedestrian volumes found along Pearl Street, between High and Purchase Streets, since the main entrance to the existing Travelers Building is located here. One Twenty Five High Street will also have a major entrance located on Pearl Street.

The results of these counts in the peak morning and evening hours can be seen in Figures 6.1-5 and 6.1-6. The largest pedestrian activity which occurs in the morning can be found on Pearl Street where 685 cross the street diagonally east of the

Existing A.M. Peak Hour Traffic Volumes



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SCALE: 1"=Approx. 670'

Fig. 6.1-3

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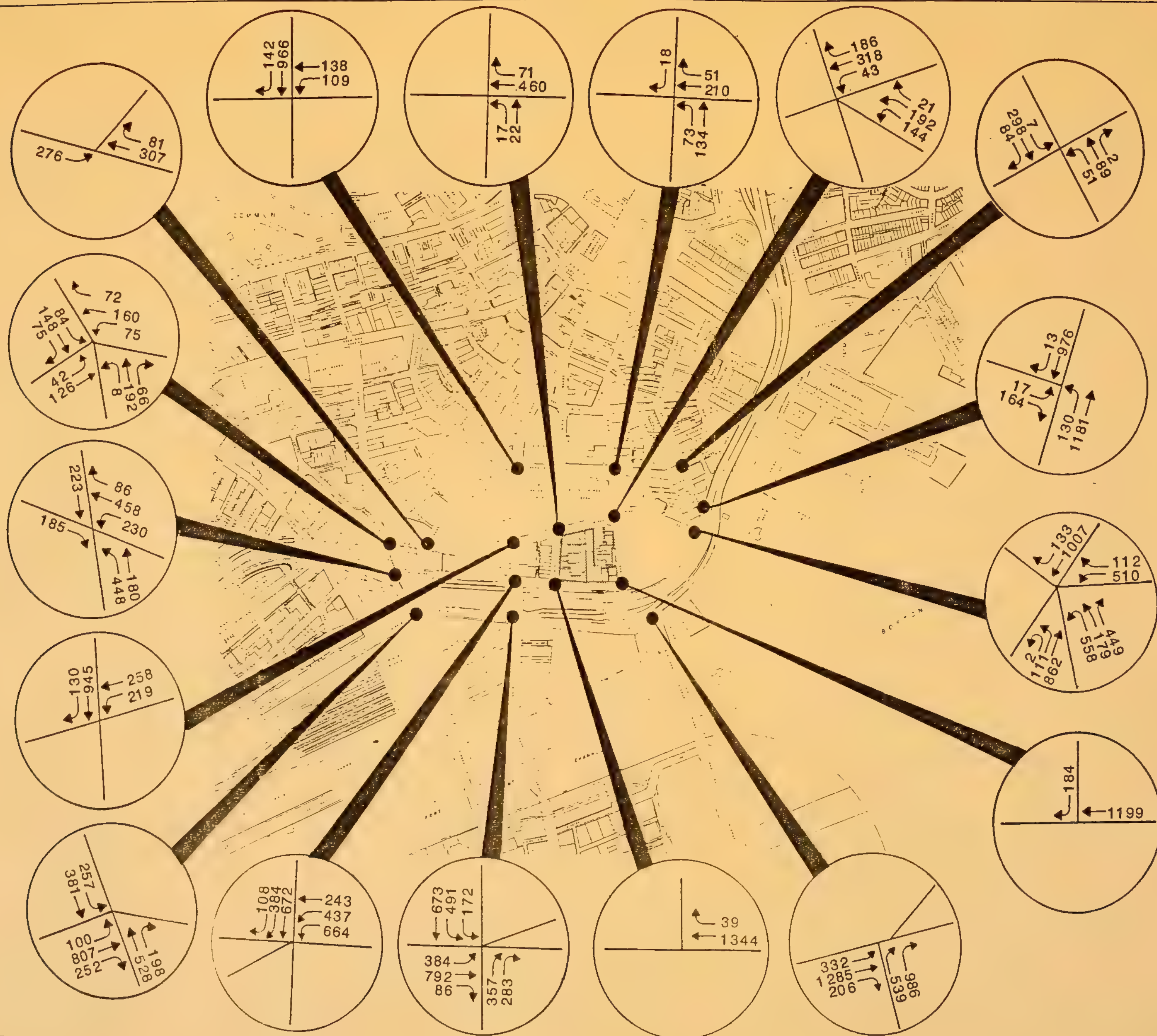
Existing P.M. Peak Hour Traffic Volumes



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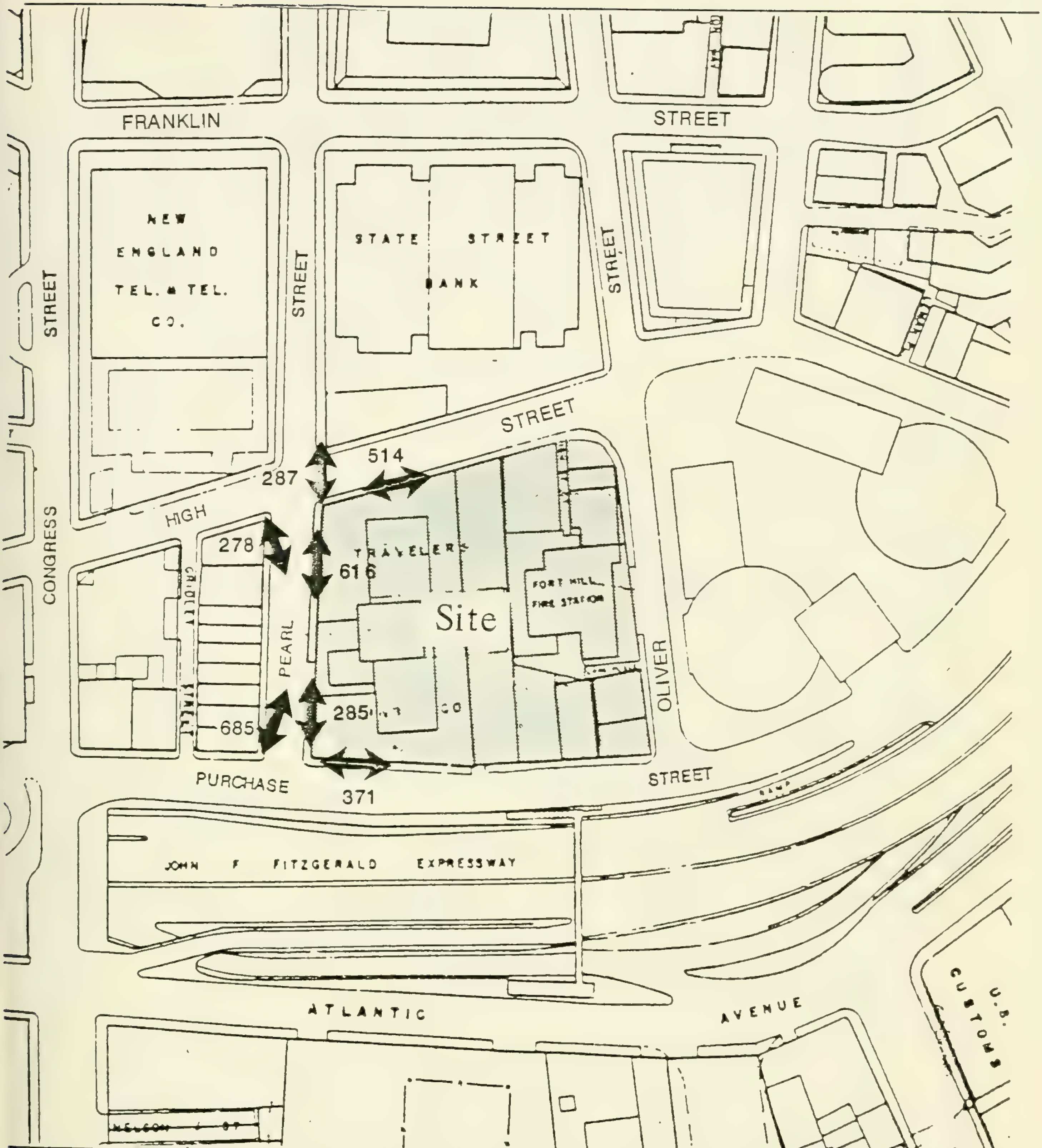
SCALE: 1"=Approx. 670'

Fig. 6.1–4



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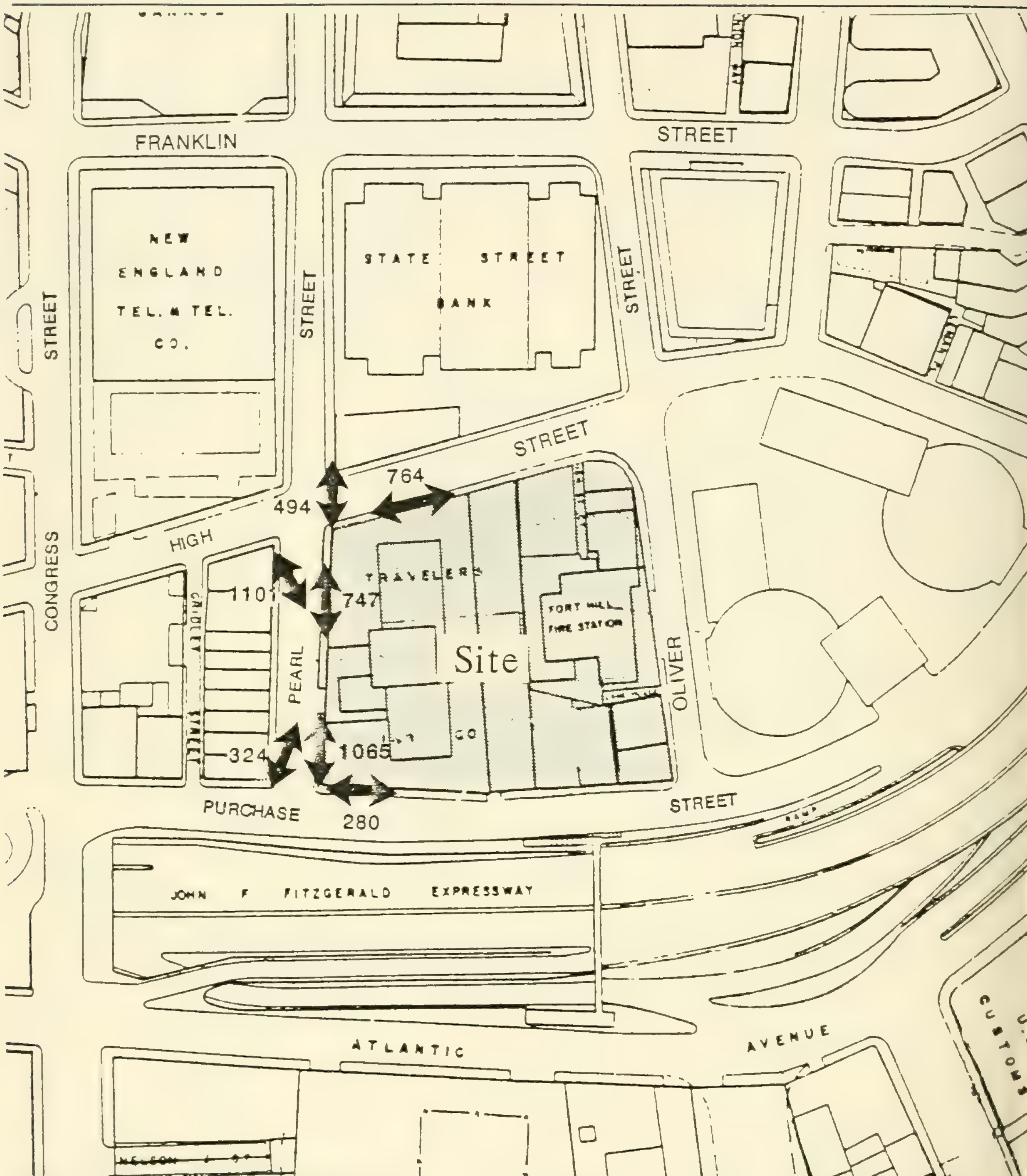
Existing A.M. Peak Hour Pedestrian Volumes

SCALE: 1"=Approx. 150'

Fig. 6.1-5

1602/487/wpr



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SCALE: 1"=Approx. 15

Existing P.M. Peak Hour Pedestrian Volumes

Fig. 6.1–6

entrance to the existing site, and 616 use the sidewalk on the north side of Pearl Street, west of the site entrance. In the evening, 1,101 cross Pearl Street diagonally west of the site entrance and 1,065 utilize the sidewalk on the north side of Pearl Street, east of the entrance. Many of these pedestrians in the evening peak are probably en route to the express bus stop on Federal Street or to South Station.

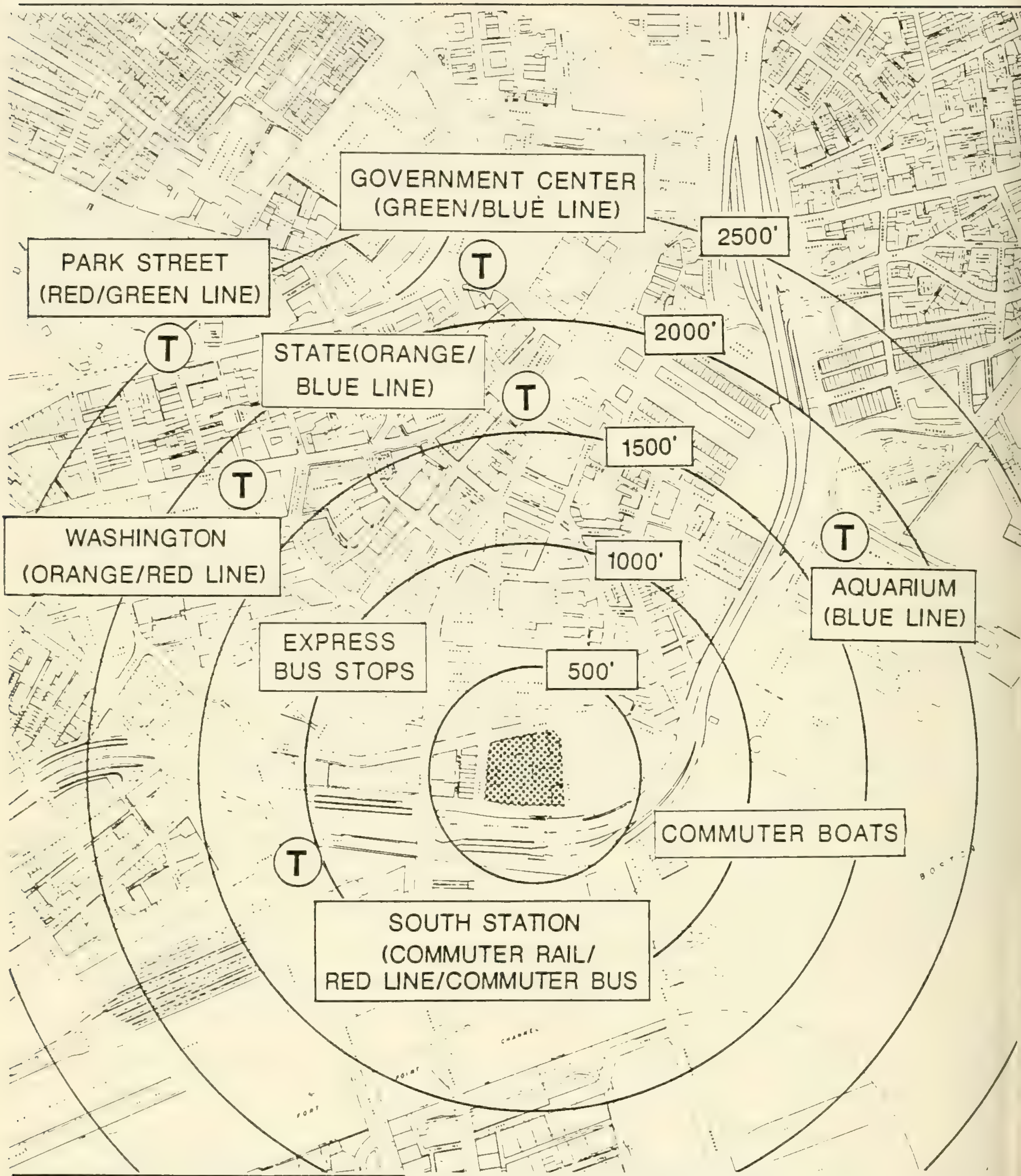
6.1.2.4 Public Transportation System

The proposed project is well served by public transportation. Figure 6.1-7 illustrates the major components of the MBTA system in the vicinity of the project and their distances from the site. Because of the proximity of the site to the rapid transit system, emphasis has been placed on system capacity and ridership.

Rapid Transit

Direct access to three of the four rapid transit lines is available within walking distance of the site. South Station, just 1,000 feet to the southwest, provides access to the Red Line. The State station, which is approximately 1,800 feet northwest of the site, is served by the Blue and Orange Lines. Access to the Aquarium Blue Line station is available within a 2,000-foot walk. Access to the Green Line is available indirectly via a transfer from the Red Line at Park Street.

Estimates of current ridership and line capacities are shown in Tables 6.1-2 and 6.1-3. All ridership and capacity figures are for the outbound direction in the PM peak hour. Total line capacity figures are based on a planning capacity for each car provided by the MBTA. In response to MBTA comments on previous environmental impact reports, transit route capacities are computed using the more conservative "planning" capacities of



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Location Of Public Transportation

SCALE: 1"=Approx. 67

LEGEND

Site

Fig. 6.1-

1602/487/wpr

transit vehicles instead of the absolute "crush" capacities. When the ridership on a transit route exceeds its planning capacity, the time required to board and discharge passengers becomes excessive and highly variable, resulting in reduced vehicle throughput and unreliable service. Loads in excess of planning capacities are possible and have been frequently observed. The planning capacity is critical for impact analysis because consistent loading above the planning capacity indicates that increased capacity through additional vehicles would be desirable in order to maintain comfortable and reliable service.

Line capacity is also based on the number of cars per train and the number of trains per hour. For the Orange and Blue Lines and the Green Line/North, these factors were based on data and schedules furnished by the MBTA. For the Red Line and the Green Line/West, these data were based on observations of transit performance made by Vanasse Hangen Brustlin over a two-week period in late September and early October 1986. Also included in those observations were recording of passenger loadings.

As shown in Table 6.1-3, the south portion of the Red Line is currently operating at slightly less than its planning capacity. It is carrying approximately 11,200 passengers in the peak direction through Andrew Station (the peak load point for the south portion). Planning capacity is 11,520 based on existing observed headways. The Orange Line/North is also carrying loads in excess of its planning capacity, with approximately 10,300 passengers and a capacity of 9,300. The Green Line/West ridership of 10,000 is well in excess of its planning capacity of 7,500 (based on existing observed headways). Trains on this segment operate near their "crush" capacity, resulting in unreliable service. The MBTA has contracted for additional cars to address the shortfall.

TABLE 6.1-2
EXISTING RAPID TRANSIT LINE CAPACITY
PM PEAK HOUR OUTBOUND

Line/Segment	Average Cars/ Train	Average Headway* (minutes)	Average No. of Trains	Car Capacity**	Line Capacity
Red Line/North					
Ashmont-Alewife	4	4	15	180	10,800***
Braintree-Alewife					
Red Line/South					
Alewife-Ashmont					
Alewife-Braintree	4	3.75	16	180	11,520
Park-Quincy					
Green Line/West					
Boston College					
Cleveland Circle	1.6+	1.67	36	130	7,500
Riverside					
Huntington Avenue					
Green Line/North					
Lechmere service	1.33+	4	15	130	2,600
Orange Line/ North-South					
Oak Grove-Forest Hills	4	4	15	155	9,300
Blue Line					
Bowdoin-Wonderland	4	4	15	110	6,600

* Red and Green Line headways are based on observed system performance in Fall 1986. Orange and Blue Line headways are based on schedules obtained from the MBTA.

** The MBTA uses these capacity estimates for planning purposes. Heavier loads can be carried and are often observed on the system.

*** Capacity is slightly lower than Red Line/South because the Quincy-Park run is not included.

\+ Represents one-car trains on the Huntington Avenue Line and a mix of one and two-car trains on all other lines.

TABLE 6.1-3
EXISTING RAPID TRANSIT RIDERSHIP
PM PEAK HOUR OUTBOUND

Line/Segment	Peak Station	Existing Ridership*	Line Capacity for Each Direction**
Red Line/North Ashmont-Alewife Braintree-Alewife	Charles	7,140	10,800
Red Line/South Alewife-Ashmont Alewife-Braintree Park-Quincy	Andrew	11,190	11,520
Green Line/West Boston College Cleveland Circle Riverside Huntington Avenue	Arlington	10,000	7,500
Green Line/North Lechmere Service	Science Park	1,100	2,600
Orange Line/North Forest Hills- Oak Grove	North Station	10,270	9,300
Orange Line/South Oak Grove- Forest Hills	Essex	7,080	9,300
Blue Line/North Bowdoin-Wonderland	Aquarium	6,120	6,600

* Red Line and Green Line/West ridership figures are based on independent observations in Fall 1986; other ridership figures are based on 1984 MBTA counts.

** See Table 6.1-2.

Bus Service

The area is well served by commuter bus, with MBTA express service provided to the Financial District (along Federal Street) from the west. Private commuter bus service is provided at South Station. MBTA express bus service to the north is provided at the Haymarket station which can be reached via the Orange Line or by an 8-10 minute walk from the site. These commuter bus lines are well used and it is the MBTA's policy to encourage continued use by minimizing standees. Consequently, the MBTA will add buses as demand warrants.

Commuter Rail

Commuter rail service to the south and west is provided approximately 1,000 feet of the site at South Station. Service to the north and northwest is provided at North Station, which can be reached via the Orange Line or a 15-minute walk. As a result, all commuter rail service is accessible from the project site.

6.1.2.5 Parking

Public parking within the Financial District and South Station area is limited. The major garage facilities within the project area include Post Office Square (950 spaces), Kingston/Bedford (735 spaces), Devonshire Street (900 spaces), One Post Office Square (400 spaces), and Beach Street (350 spaces). Several other smaller surface lots are scattered throughout the area. With the recent loss of several major facilities at Fort Hill Square, on High Street and on Kilby Street, parking demand within the area is currently at or near the capacity of all of the remaining major facilities. In addition, the city is in the process of selling the Kingston/Bedford garage for redevelopment.

Short-term on-street parking is fully utilized by mid-morning according to counts taken in 1982 and reported in Parking in Central Boston.

6.1.3 Probable Project Impacts

6.1.3.1 Daily Trip Generation

In order to assess the impact of the project on the transportation system in the site area, travel demand by type of use and user has been estimated. The procedures used in estimating these trips consisted of calculating person-trips per 1,000 square feet of floor space. Trip rates and modal splits have been categorized as office vs. retail and work vs. non-work. Rates used in the calculations are identical to those used in several recent downtown environmental assessment reports, including 125 Summer Street and the Final Environmental Impact Report for International Place.

The development program analyzed for the project calls for 1,356,000 square feet of office space and 34,000 square feet of retail space. Although the final development program may differ slightly from the size analyzed, this will have no impact on the results of the trip generation. Tables 6.1-4 and 6.1-5 summarize trip rates and modal splits assumed in the analysis and the resultant person-trips based on the development plan analyzed.

A 70 percent transit mode split factor for work trips was used in the trip generation calculations. This figure, and the others found in Table 6.1-5, are based on data contained within the December 1983 report, Parking in Central Boston: Meeting the Access Needs of a Growing Downtown. The 70 percent transit figure used has also appeared in other approved impact reports for downtown projects such as the International Place EIR. It

TABLE 6.1-4
TOTAL DAILY PERSON-TRIPS

User	Office			Retail		
	In	Out	Total	In	Out	Total
Generation Rates*						
Worker	4.40	4.40	8.80	2.75	2.75	5.50
Non-Worker	2.35	2.35	4.70	16.40	16.40	32.80
Total	6.75	6.75	13.50	19.15	19.15	38.30
Generated Trips**						
Worker	5,966	5,966	11,932	94	94	188
Non-Worker	3,187	3,187	6,374	558	558	1,116
Total	9,153	9,153	18,306	652	652	1,304

* Person trips per 1,000 square feet
** Total trips per day

TABLE 6.1-5
DAILY PERSON-TRIPS BY MODE SPLIT

User	Office			Retail		
	Auto	Transit	Walk	Auto	Transit	Walk
Percentages						
Worker	30.0	70.0	0.0	30.0	70.0	0.0
Non-Worker	27.5	57.5	15.0	27.5	32.5	40.0
Daily Person-Trips						
Worker	3,580	8,352	0	56	132	0
Non-Worker	1,753	3,665	956	307	363	446

should also be noted that the non-work trip transit factor is based on modal split assumptions used in the downtown parking report for the area in which the project is located.

The modal split figure for work trips of 30 percent auto utilized in the calculations may, in reality, prove to be somewhat conservative (i.e., on the high side). Summarized results from the 1980 "Downtown Crossing Evaluation Building Surveys," included in the Parking in Central Boston report state that only 16.7 percent of the trips generated by the existing Travelers Building arrive by auto. This low auto usage can mainly be attributed to the limited 105-space parking supply presently available on the site. The results of this survey also indicate that the percentage of trips generated by other major developments in proximity to One Twenty Five High Street, which arrive by auto, is also low. Of the 30 developments included in the survey, the percentage of trips which arrive by auto, presumably both work and non-work trips, exceeds 30 percent at only six locations. A later survey of employees conducted in 1982 by the City of Boston indicated a significantly higher auto use for work trips of 42.9 percent for the existing Travelers Building. However, this survey was conducted when both the Fort Hill and High Street parking garages were still in operation. Although the parking formerly found in these garages has been replaced within the new developments located on these sites, the new projects have greatly increased the demand for these spaces. Therefore, the option of parking at these facilities is no longer available to employees working in the Travelers Building. This, in turn, would cause the 43 percent auto use figure to decrease. Yet another survey, conducted by the BRA in 1979 states that, in general, only 32 percent of the work trips generated in the Financial District arrive by auto.

The 70 percent transit figure has also been generally confirmed based on the Real Estate Operations Survey of New England Telephone (NET) employees presented in Appendix A. New England Telephone will be a major tenant in One Twenty Five High Street. According to the results of the survey, 64.1 percent of all NET employees who work at the company's five Boston locations utilize public transit as their primary mode of commuting to work. However, when a weighted average is applied to 185 Franklin Street, 265 Franklin Street and 99 High Street, the three NET work locations all situated within a block of One Twenty Five High Street, a 68.75 percent transit figure is obtained. This 69 percent transit value is seen as indicative of the mode split characteristics which exist in the Financial District. The results from the BRA survey presented above which cite 32 percent auto use in this area of the city serve as a check to this 69 percent transit figure.

Table 6.1-6 summarizes anticipated vehicle occupancy rates for those trips arriving by auto. These rates are based primarily on information reported in Parking in Central Boston.

Applying the occupancy rates given in Table 6.1-6 to the person-trips arriving by auto projected in Table 6.1-5 results in a total estimate of 3,442 daily vehicle-trips (Table 6.1-7). These are distributed equally to inbound and outbound trips (1,721 each way). The 3,442 daily vehicle-trips include employee-related trips, visitors, taxis, and delivery vehicles.

TABLE 6.1-6
VEHICLE OCCUPANCY FACTORS

	Use	
Trip Type	Office	Retail
Work	1.8	1.4
Non-Work	1.4	1.9

TABLE 6.1-7
DAILY VEHICLE TRIPS (TWO-WAY)

Trip Type	Use Office	Retail	Total
Work	1,989	40	2,029
Non-Work	1,252	161	1,413
Total	3,241	201	3,442

6.1.3.2 Peak Hour Trip Generation

The number of trips occurring during the peak commuter hours are of greater concern than the total daily trips. It is these peak periods which are used to evaluate the performance of the transportation system. The peak hour percentages shown in Table 6.1-8 were multiplied by one-half (to reflect directional travel) of the daily trips in Tables 6.1-5 (for transit and walk trips) and 6.1-7 (for vehicle-trips) to obtain the results shown in Table 6.1-9. A total of 613 inbound vehicle-trips is projected for the morning peak hour, while 622 outbound vehicle-trips are projected for the evening peak. Approximately 2,500 person-trips are estimated on all forms of public transportation in the peak direction during both peak hours.

TABLE 6.1-8
PERCENTAGES OF DAILY TRIPS
DURING PEAK HOURS BY TYPE AND DIRECTION*

	Work AM	Work PM	Non-Work AM	Non-Work PM
Office				
Arrivals	55%	2%	10%	2%
Departures	1%	55%	1%	10%
Retail				
Arrivals	10%	10%	1%	5%
Departures	1%	20%	1%	10%

* From International Place EIR

1602/487/wpr

TABLE 6.1-9
TOTAL PROJECT PEAK HOUR TRIPS BY MODE
(PEAK DIRECTION)

	AM Inbound			PM Outbound		
	Auto*	Transit**	Walk	Auto*	Transit**	Walk
Office						
Work	547	2,297	0	547	2,297	0
Non-Work	63	183	48	63	183	48
Retail						
Work	2	7	0	4	13	0
Non-Work	1	2	2	8	18	22
Total	613	2,489	50	622	2,511	70

* Vehicle trips
** Person trips on all forms of public transportation

6.1.3.3 New Additional Peak Hour Trips

The peak hour trips projected above represent the total number of trips generated by the project when it is fully developed as proposed. However, the existing Travelers Building on the development site is currently generating trips which are part of the existing travel volumes on the area's street system. Due to this fact, traffic generated by the existing land use can be subtracted from the figures calculated above in order to establish the net increase in traffic generated by the site.

Traffic generation for the existing land use was estimated using the same procedure described above to project future travel demand. Table 6.1-10 summarizes the net increases in peak hour trips generated by the proposed project when fully developed. These increases range from 436 to 445 vehicle-trips and from 1,776 to 1,798 transit person-trips during each peak hour. Table 6.1-11 shows demand by direction, mode and time period.

TABLE 6.1-10
NET NEW PROJECT PEAK HOUR TRIPS BY MODE

	AM Inbound			PM Outbound		
	Auto*	Transit**	Walk	Auto*	Transit**	Walk
Office						
Work	389	1,636	0	389	1,636	0
Non-Work	44	131	34	44	131	34
Retail						
Work	2	7	0	4	13	0
Non-Work	1	2	2	8	18	22
Total	436	1,776	36	445	1,798	56

* Vehicle trips
** Person trips on all forms of public transportation.

TABLE 6.1-11
NET NEW DAILY TRIPS BY MODE

Daily		Auto*	Transit**	Walk**
AM:	In	436	1,776	36
	Out	14	44	6
	Total	450	1,820	42
PM:	In	30	101	18
	Out	445	1,798	56
	Total	475	1,899	74

* Vehicle trips.
** Person trips on all forms of public transportation.

6.1.3.4 Delivery Vehicle and Taxi Trips

A certain amount of the total daily vehicle generation will consist of taxi and delivery vehicle-trips. Delivery vehicles are typically single-unit, two-axle vans and are not large semi-trucks. Table 6.1-12 summarizes the net increase in expected delivery vehicle traffic for the project's office and retail uses.

TABLE 6.1-12
NET NEW DAILY DELIVERY VEHICLE ARRIVALS

	Office	Retail	Total
Generation Rates	0.21 Arrivals/ 1,000 Sq.Ft.	0.21 Arrivals/ 1,000 Sq.Ft.*	
1994 Build Deliveries	203	8	211

* Based on Copley Place EIR.

At 1994 Build conditions, approximately 211 deliveries are expected daily at the proposed development. One Twenty Five High Street would average almost 24 delivery vehicles per hour, assuming a constant distribution over a nine-hour day. If it is further assumed that each delivery vehicle arrives and departs within the same hour, then a maximum of approximately 48 delivery vehicle trips per hour would occur. This volume constitutes approximately 8 percent of both the morning and evening peak hour traffic generated by the project. By comparison, truck traffic currently comprises approximately 7 percent of morning peak hour volumes along Purchase Street.

The total net increase in taxi traffic is summarized in Table 6.1-13. At 1994 Build conditions, approximately 108 taxi arrivals per day are expected with 98 projected for the development's office uses while only 10 are projected for the development's retail uses. As stated later in the Access Plan, provision should be made for a taxi stand on either High Street or Pearl Street.

TABLE 6.1-13
NET NEW DAILY TAXI ARRIVALS

	Office	Retail	Total
Generation Rates	0.75 Arrivals/ 100 Person-Trips	0.75 Arrivals/ 100 Person-Trips*	
1994 Build Deliveries	98	10	108

* Based on Highway Research Board, NCHRP Report No. 62, Urban Travel Patterns for Hospitals, Universities, Office Buildings and Capitols, 1969.

6.1.3.5 Trip Distribution and Assignment

The vehicle-trips generated by the proposed development were distributed to the transportation system according to the trip distribution pattern listed in Table 6.1-14 and shown in Figure 6.1-8. This is the same pattern that has been established in other major downtown EIRs, except that it has been modified to reflect the anticipated opening of the Third Harbor Tunnel by the 1994 Build year. Due to this, the trip distribution patterns to the northeast have been subsequently adjusted. It is now projected that 5 percent of the net new vehicle-trips generated by the project will use the Third Harbor Tunnel. The Depressed Central Artery, scheduled for completion beyond the 1994 Build analysis year, was not considered in this report. However, the relocation of the existing High Street off-ramp from the existing Central Artery to Purchase Street was assumed since it is now under design at the time the analysis was conducted (other options have recently been proposed).

TABLE 6.1-14
TRIP DISTRIBUTION

Direction	Percent
Northeast (via Third Harbor Tunnel)	5%
Northeast (Other)	9%
North	14%
Northwest	9%
West	17%
Southwest	22%
Southeast	24%
Total	100%

Assignment of these trips to the local street system in the vicinity of the site is a function of the access to the proposed garage, the existing pattern of one-way streets, and the location of the existing Central Artery ramps. Also considered in these assignment patterns were the results of a recent "Data and Traffic Summary" of employees of New England Telephone, the anchor tenant.

6.1.3.6 Background Traffic Growth

In order to assess future conditions, it is not only necessary to project development-related traffic increases, but also to project increases in background traffic. Growth in background traffic is a function of other development activity expected within the area. This growth can be projected by the application of a generalized growth factor or by the assessment of specific development proposals. For this analysis, the projection of background or No-Build traffic (i.e., future traffic without One Twenty Five High Street) was based on the assessment of other specific development proposals projected to be completed by 1994,

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SCALE: 1"=Approx. 670'

Trip Distribution Map

LEGEND

Site

Fig. 6.1-8

the year when One Twenty Five High Street is expected to be fully occupied. This year was selected as part of the scoping process with the BRA and the Boston Transportation Department (BTD).

Table 6.1-15 lists the projects included in the development of the 1994 No-Build networks and the projected uses for each development. When applicable, previous documentation presented in other Environmental Impact Reports and Environmental Assessments was utilized where traffic volumes were available. Where volumes were not available from other sources, the trip generation assumptions described earlier were applied to the projected uses for each identified background development to obtain projected vehicle, transit and pedestrian trips. A summary of daily and peak hour trip generation data for these background developments can be found in the Appendix A. The vehicle-trips were assigned to the roadways to obtain the morning and evening peak hour No-Build networks shown in Figures 6.1-9 and 6.1-10, respectively. The projected traffic from One Twenty Five High Street was added to these 1994 No-Build volumes to obtain the 1994 Build volumes shown in Figures 6.1-11 and 6.1-12.

It should be noted that the redevelopment plans for South Station were considered in developing background volumes, as shown in Table 6.1-15. By 1994, the head house will be completed, providing in excess of 100,000 square feet of office and retail space. In addition, the refurbishing of the train concourse, loading platforms and the construction of a new 600-space garage and intercity bus terminal should also be completed by that time. Other development plans for the site include an additional 1,500 parking spaces and 400,000 square feet of office space, 600 hotel rooms and a 250,000 square foot "High-Tech Center," all to be completed by 1995 under optimistic conditions. To be conservative, this 1995 development was included in the 1994 analysis.

TABLE 6.1-15
1994 BACKGROUND DEVELOPMENT

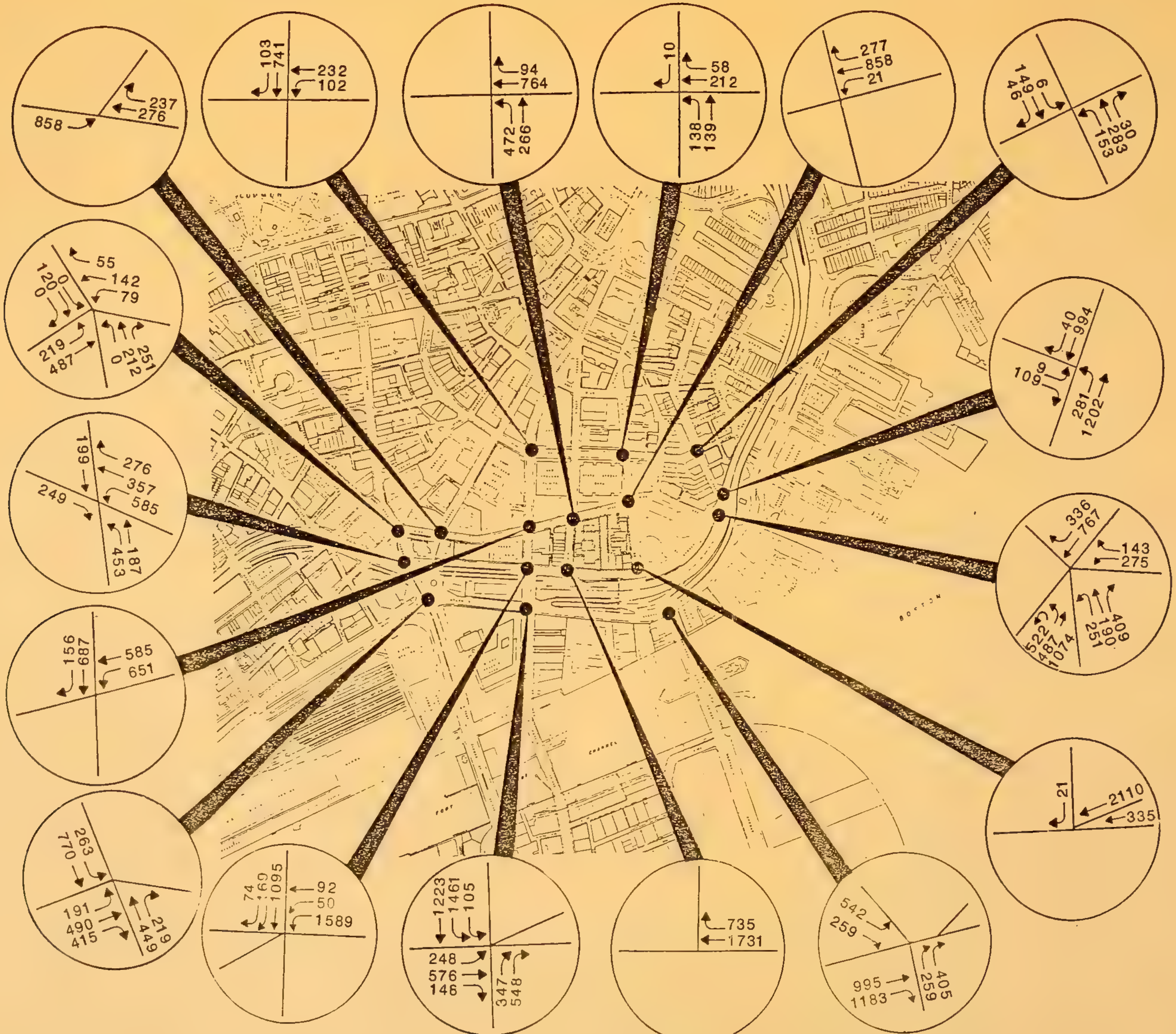
Development	Size	Use
Commonwealth Pier 5	752,000 SF*	World Trade Center
Fish Pier 6	130,000 SF	Office
	18,000 SF	Fish Market
Commonwealth Flats	460,000 SF	Office
	405,000 SF	Showroom
Cabot, Cabot & Forbes (Northern Ave. Parcels)	500,000 SF	Office
	10,000 SF	Retail
Boston Wharf Company	321,000 SF	Office
	- 557,000 SF	Industrial
	236 DU**	
Boston Marine Industrial Park	625,000 SF	Light Industrial/ Fish Processing
Fan Pier & Pier 4	1,897,000 SF	Office
	234,000 SF	Retail
	1,096 Rooms	Hotel
	1,097 DU	Residential
150 Federal Street	475,000 SF	Office
	10,000 SF	Retail
Rowes Wharf	665,000 SF	Office/Retail/ Residential
International Place	1,700,000 SF	Office
	100,000 SF	Retail
Marketplace Center	442,000 SF	Office/Retail
75 State Street	685,000 SF	Office
	15,000 SF	Retail
101 Federal Street	497,000 SF	Office
	10,000 SF	Retail

TABLE 6.1-15 (Continued)
1994 BACKGROUND DEVELOPMENT

Development	Size	Use
500 Boylston Street	1,200,000 SF	Office
	100,000 SF	Retail
99 Summer Street	285,000 SF	Office
South Station (Phases I & II)	75,000 SF	Office
	35,000 SF	Retail
		Train Concourse
		Platforms
South Station*** (Phase III)	400,000 SF	Office
	600 Rooms	Hotel
	250,000 SF	R&D
101 Arch Street	340,000 SF	Office
	46,000 SF	Retail
Milk & Broad Street	223,000 SF	Office
	17,000 SF	Retail
125 Summer Street	482,000 SF	Office
	13,000 SF	Retail
Lincoln Street/ Essex Street Site	350,000 SF	Office
	17,000 SF	Retail
Bedford Street Garage Development	700,000 SF	Office
	15,000 SF	Retail

* SF - Square feet.
** DU - Dwelling unit.
*** Phase III development to be optimistically completed by 1995, but is included in the 1994 analysis as a conservative measure.

1994 No Build A.M. Peak Hour Traffic Volumes



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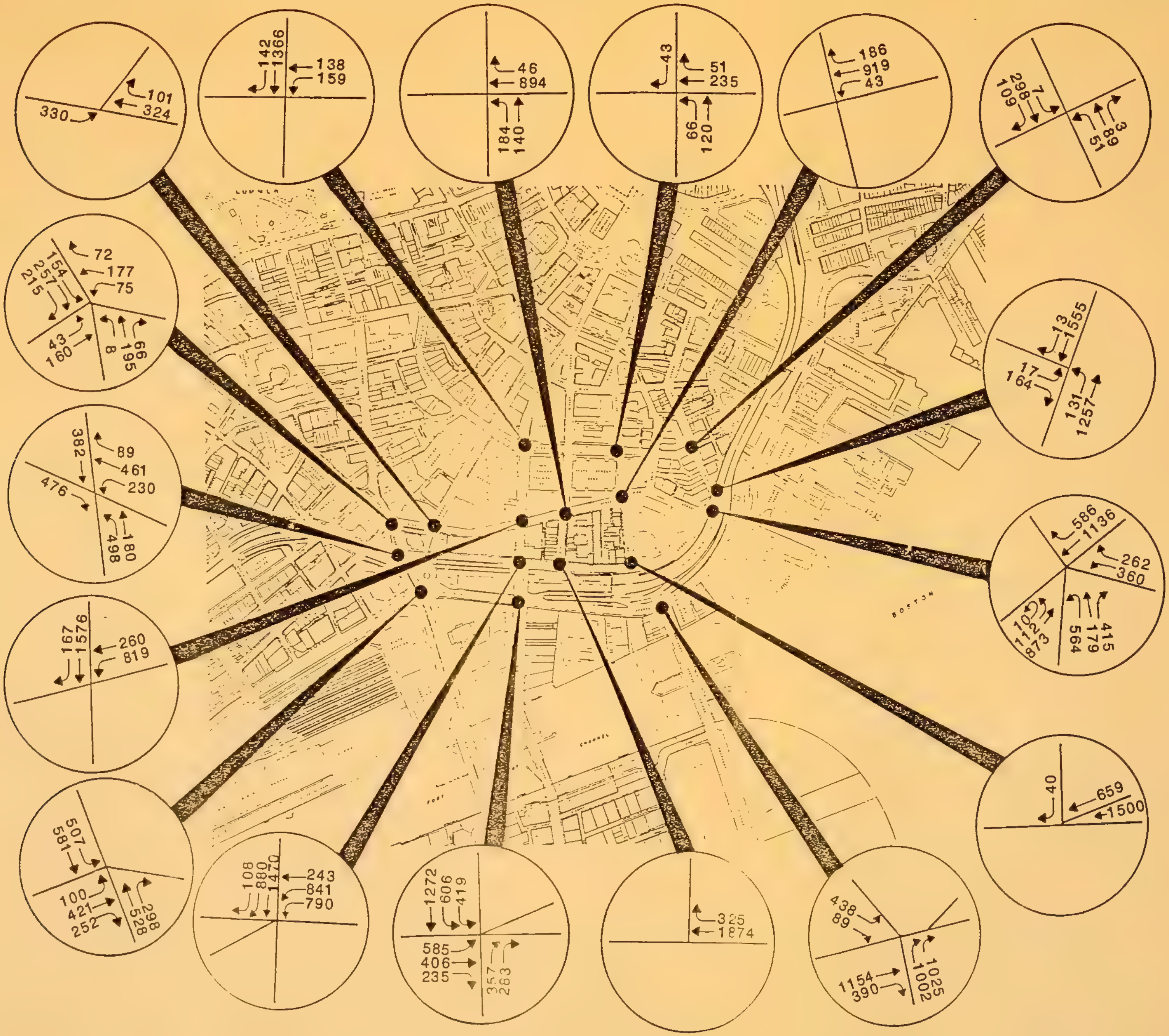
SCALE: 1"=Approx. 670'

Fig. 6.1–9

1994 No Build P.M. Peak Hour Traffic Volumes



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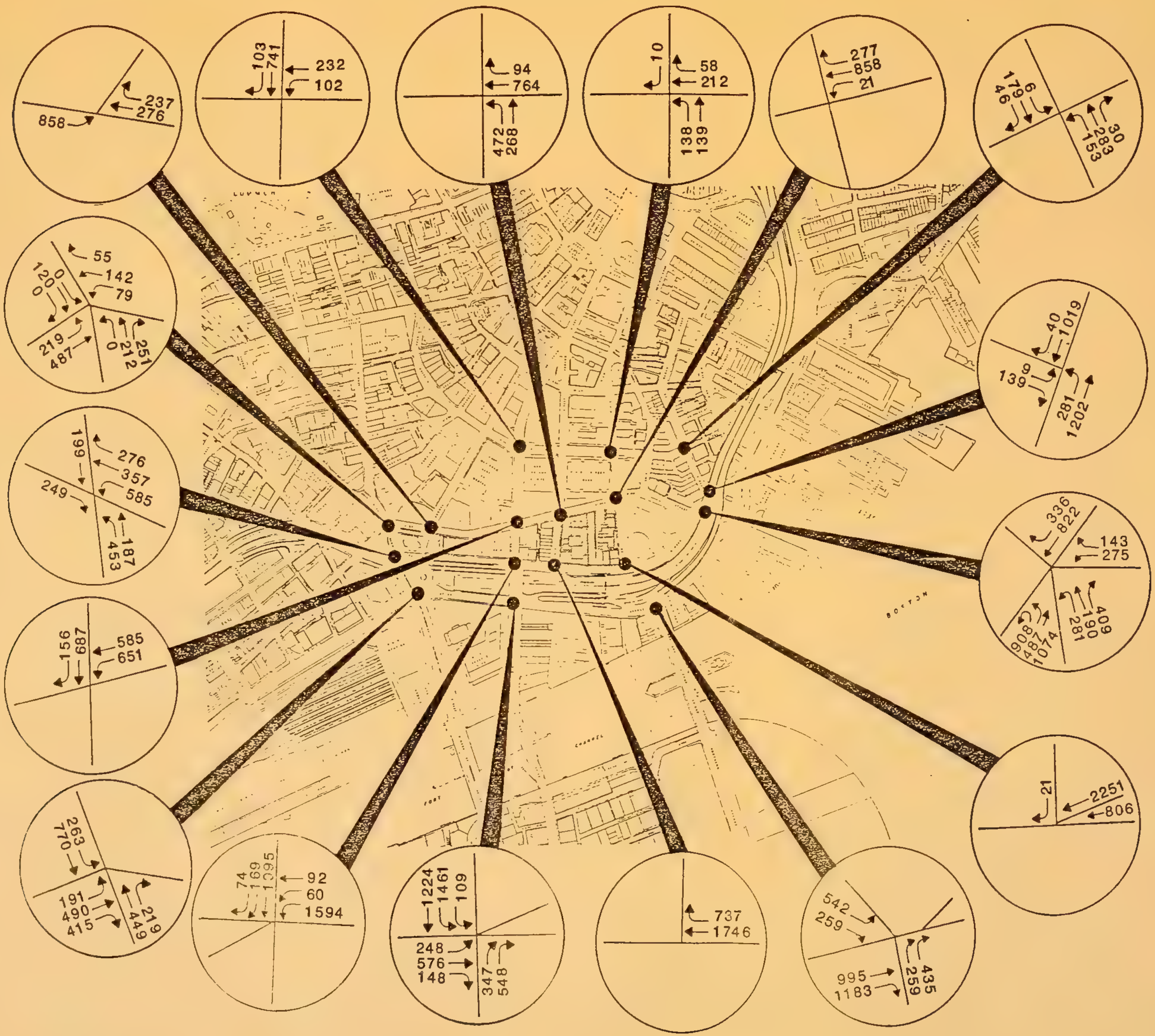
SCALE: 1"=Approx. 670'

Fig. 6.1–10

1994 Build A.M. Peak Hour Traffic Volumes



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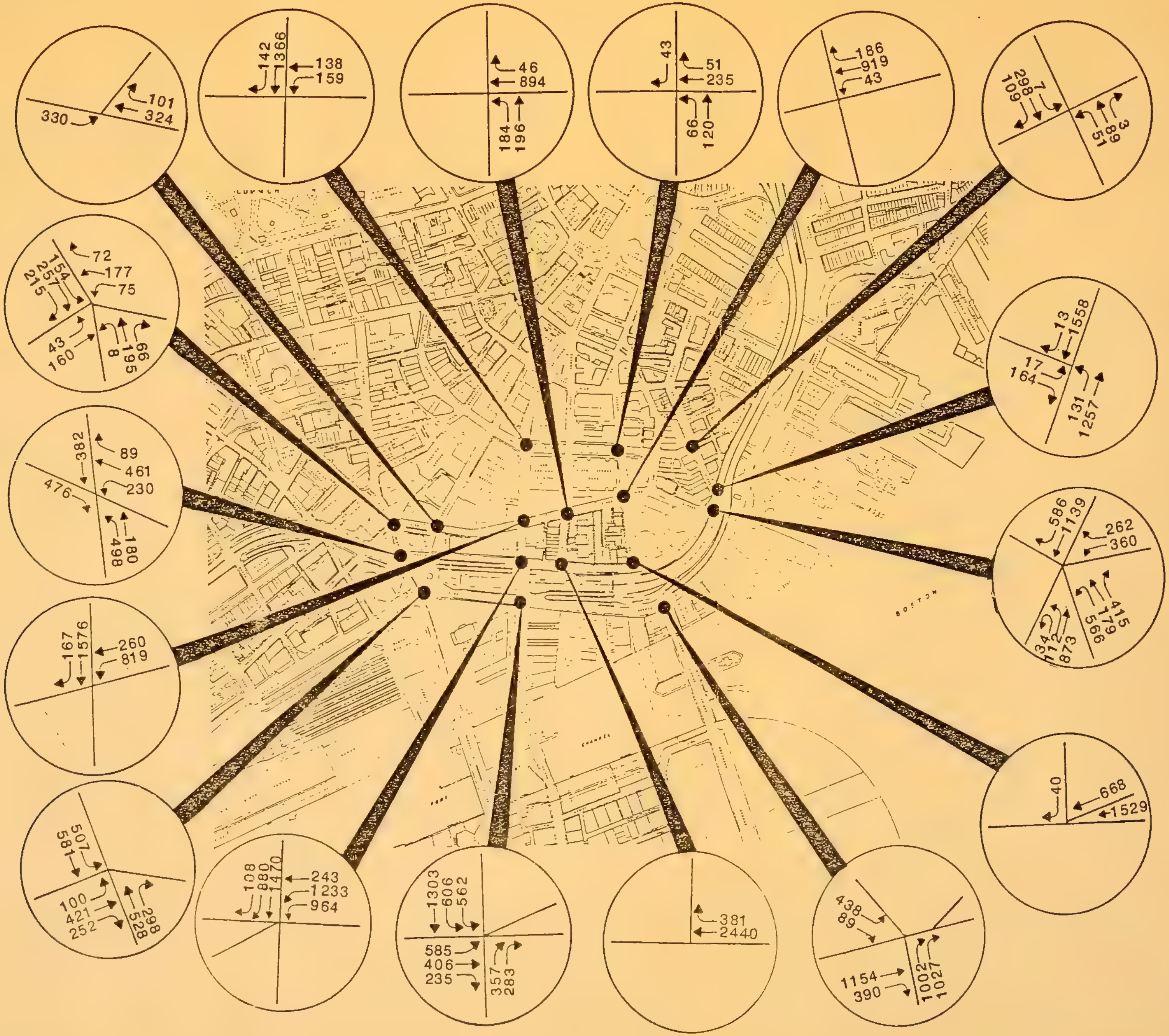
SCALE: 1"=Approx. 670'

Fig. 6.1-11

1994 Build P.M. Peak Hour Traffic Volumes



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SCALE: 1"=Approx. 670'

Fig. 6.1-12

The No-Build and Build networks assume, as previously stated, the relocation of the High Street Central Artery off-ramp to Purchase Street, as outlined in the International Place EIR, and the completion of the Third Harbor Tunnel. The future networks, however, do not include the depression of the Central Artery, as that project would not be completed until sometime after 1994.

6.1.3.7 Intersection Analysis

Traffic Operations Measures

o Signalized Intersections

An intersection Level of Service (LOS) analysis was undertaken in the One Twenty Five High Street study area using current methodologies for signalized intersections as defined in the 1985 Highway Capacity Manual (Special Report 209, as published by the Transportation Research Board, Washington, DC). While similar to the critical movement analysis procedures (Transportation Research Board, Transportation Research Circular Number 212, Interim Materials on Highway Capacity, Washington, D.C., January, 1980 (Planning Criteria)) conducted in recent environmental assessments (most recently the 125 Summer Street project), the new methodologies are more technically comprehensive and consider more factors affecting traffic flow. The analysis relates roadway geometry (lanes, width, etc.), traffic demand and composition, and traffic signal timing (if applicable) to the identification of intersection deficiencies. Also, unlike the LOS criteria based on volume-to-capacity ratios found in Circular 212, the current methodologies base LOS on intersection delay. Due to this fact, LOS results for a particular intersection may vary from earlier Circular 212 analyses. Level of service for signalized intersections is defined in terms of delay which is a measure of driver discomfort, frustration, fuel consumption and

travel time. The delay is stated in terms of average stopped delay per vehicle. Table 6.1-16 summarizes the criteria for signalized intersection level of service.

TABLE 6.1-16
LEVEL OF SERVICE CRITERIA FOR
SIGNALIZED INTERSECTIONS

Level of Service	Stopped Delay per Vehicle (sec)
A	$\leq$5.0
B	5.1 to 15.0
C	15.1 to 25.0
D	25.1 to 40.0
E	40.1 to 60.0
F	>60.0

SOURCE: Highway Capacity Manual, Special Report 209, Transportation Research Board, Washington, D.C., 1985.

Level of service is an index generally used to rate intersection operations. Level of service can range from LOS "A" to LOS "F". Level of Service "A" describes operations with very low delay, i.e., less than 5.0 seconds per vehicle. This occurs when progression is extremely favorable, and most vehicles arrive during the green phase. Most vehicles do not stop at all. Level of Service "F" describes operations with delay in excess of 60.0 seconds per vehicle. This condition, characterized by congested conditions, is considered to be unacceptable to most drivers. Between LOS "A" and LOS "F", traffic conditions and therefore delays become progressively worse. Level of Service "D" or better is generally considered acceptable, particularly in urban areas.

o Unsignalized Intersections

Level of service for unsignalized intersections is based on the number of acceptable gaps available in the major street traffic flow that may be utilized by minor street vehicles. The criteria shown in Table 6.1-17 are based on the available reserve (or unused) capacity (measured in passenger cars per hour) for the minor street movement in question. The table also includes a qualitative index of delay to minor street traffic.

TABLE 6.1-17
LEVEL OF SERVICE CRITERIA FOR
UNSIGNALIZED INTERSECTIONS

Reserve Capacity	Level of Service	Expected Delay to Minor Street Traffic
> 400	A	Little or no delay
300-399	B	Short traffic delays
200-299	C	Average traffic delays
100-199	D	Long traffic delays
0-99	E	Very long traffic delays

SOURCE: Highway Capacity Manual, Special Report 209, Transportation Research Board, Washington, D.C., 1985.

Capacity Analysis

All study intersections were analyzed using the analysis procedures described earlier in this section. Tables 6.1-18 and 6.1-19 and Figure 6.1-13 summarize the results of the capacity analyses for all intersections for Existing, No-Build and Build conditions. However, one study intersection, Purchase Street and Pearl Street, does not appear in the summary tables or figure due to the fact that there are no conflicting volumes at this intersection. Therefore, standardized analysis techniques could not be applied.

TABLE 6.1-18
INTERSECTION LEVEL OF SERVICE SUMMARY
AM PEAK PERIOD

Location	Existing Analysis V/C*	Existing Analysis Delay**	Existing Analysis LOS***	No-Build Analysis 1994 V/C	No-Build Analysis 1994 Delay	No-Build Analysis 1994 LOS	Build Analysis 1994 V/C	Build Analysis 1994 Delay	Build Analysis 1994 LOS
SIGNALIZED									
Summer/South/High	0.34	14.2	B	0.52	15.1	C	0.52	15.1	C
Summer/Purchase/Surface	0.51	17.2	C	0.58	18.9	C	0.58	18.9	C
Summer/Atlantic	0.83	29.9	D	0.87	23.8	C	0.87	23.8	C
High/Federal	0.47	12.5	B	0.61	14.2	B	0.61	14.2	B
Congress/Franklin	0.37	13.2	B	0.48	13.8	B	0.48	13.8	B
Congress/High	0.45	17.9	C	0.75	60.0+	F	0.75	60.0+	F
Congress/Purchase	0.59	11.6	B	0.98	18.8	C	0.98	18.9	C
Congress/Atlantic	0.84	19.8	C	1.40	60.0+	F	1.40	60.0+	F
Pearl/High	0.41	10.8	B	0.73	60.0+	F	0.73	60.0+	F
Atlantic/Northern	0.75	15.2	C	1.64	60.0+	F	1.65	60.0+	F
Broad/Surface	0.41	13.5	B	0.59	17.9	C	0.63	19.1	C
Surface/High/Atlantic	1.06	60.0+	F	1.52	60.0+	F	1.81	60.0+	F

	Reserve Capacity^	LOS	Reserve Capacity	LOS	Reserve Capacity	LOS
UNSIGNALIZED						
Oliver/Franklin	310	B	421	A	421	A
Oliver/High	259	C	N/A****	N/A	N/A	N/A
Oliver/Purchase	405	A	345	B	236	C
Broad/Franklin	832	A	832	A	832	A

* V/C = Volume-to-capacity ratio.
** Delay = Average intersection delay in seconds.
*** LOS = Level of Service.
**** N/A = No conflicting volumes due to relocation of High Street off-ramp. Therefore intersection cannot be analyzed by standardized techniques.
^ Reserve capacity in vehicles per hour.

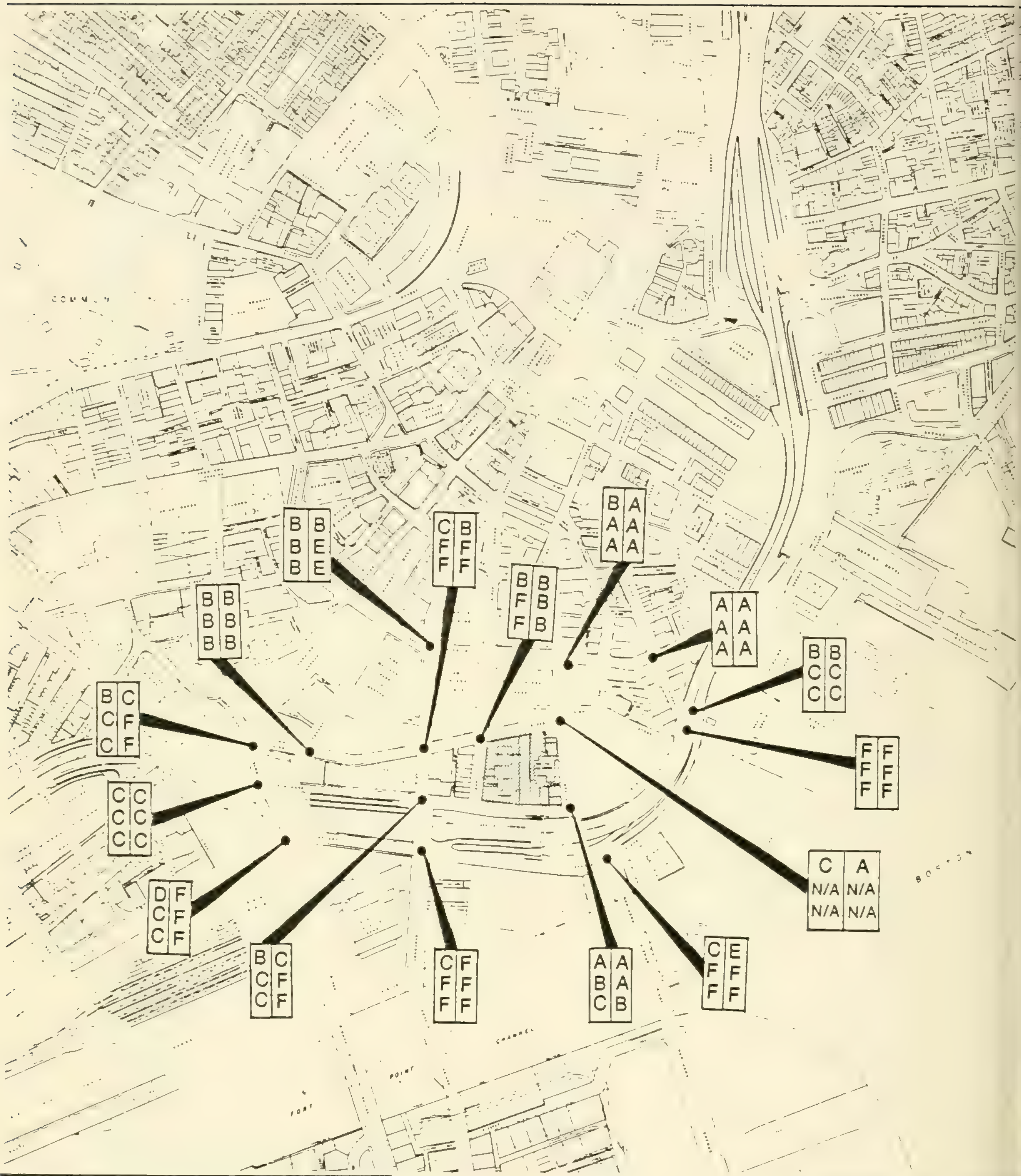
TABLE 6.1-19
INTERSECTION LEVEL OF SERVICE SUMMARY
PM PEAK PERIOD

Location	Existing Analysis			No-Build Analysis 1994			Build Analysis 1994		
	V/C*	Delay**	LOS***	V/C	Delay	LOS	V/C	Delay	LOS
SIGNALIZED									
Summer/South/High	0.43	15.9	C	0.75	60.0+	F	0.75	60.0+	F
Summer/Purchase/Surface	0.46	20.3	C	0.53	19.1	C	0.53	19.1	C
Summer/Atlantic	0.78	60.0+	F	1.03	60.0+	F	1.03	60.0+	F
High/Federal	0.26	10.5	B	0.29	10.8	B	0.29	10.8	B
Congress/Franklin	0.52	14.8	B	0.65	43.1	E	0.65	43.1	E
Congress/High	0.49	10.7	B	1.02	60.0+	F	1.02	60.0+	F
Congress/Purchase	0.82	19.3	C	1.25	60.0+	F	1.38	60.0+	F
Congress/Atlantic	0.95	60.0+	F	1.22	60.0+	F	1.28	60.0+	F
Pearl/High	0.27	8.7	B	0.57	13.5	B	0.62	14.3	B
Atlantic/Northern	1.02	44.3	E	1.44	60.0+	F	1.44	60.0+	F
Broad/Surface	0.50	14.3	B	0.57	15.7	C	0.57	15.8	C
Surface/High/Atlantic	1.28	60.0+	F	1.19	60.0+	F	1.24	60.0+	F

	Reserve Capacity^	LOS	Reserve Capacity	LOS	Reserve Capacity	LOS
UNSIGNALIZED						
Oliver/Franklin	517	A	492	A	492	A
Oliver/High	592	A	N/A****	N/A	N/A	N/A
Oliver/Purchase	534	A	406	A	395	B
Broad/Franklin	868	A	845	A	845	A

* V/C = Volume-to-capacity ratio.
** Delay = Average intersection delay in seconds.
*** LOS = Level of Service.
**** N/A = No conflicting volumes due to relocation of High Street off-ramp. Therefore intersection cannot be analyzed by standardized techniques.
^ Reserve capacity in vehicles per hour.

1602/387/wpr



Legend:

AM	PM	
X	X	Existing
X	X	No-Build
X	X	Build

▭ Site

Intersection Level Of Service

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SCALE: 1"=Approx. 67

Fig. 6.1-13

1602/487/vpr

Four study locations were calculated to operate at Level of Service (LOS) "E" or "F" under existing conditions. The Atlantic Avenue intersections at Summer Street, Congress Street, and Northern Avenue presently operate in the evening peak hour at LOS "F", "F" and "E", respectively. The intersection of Surface Artery/High Street/Atlantic Avenue operates at LOS "F" in both the morning and evening peaks. All other locations operate at LOS "D" or better in both peak hours. However, because of their importance, these intersections control the flow of traffic throughout the study area. Congestion which results from these intersections can extend beyond and adversely affect other locations.

It should be noted that numerous ongoing construction projects in the area may be causing poorer levels of service at some locations than are indicated in Table 6.1-18 and 6.1-19. The levels of service shown are representative of base conditions in the study area without disruptions for temporary construction projects. At some locations, construction activity restricts the number of lanes available for traffic, resulting in increased congestion, greater delay, and reduced levels of service. At other locations, where there is no construction activity, there may be additional traffic as a result of drivers avoiding construction areas. This additional traffic results in increased congestion, greater delay, and reduced levels of service at these locations.

Tables 6.1-18 and 6.1-19 also illustrate changes in volume-to-capacity ratios, delays and levels of service under No-Build conditions in 1994. In the morning peak hour, eight of the 16 intersections analyzed experience a decline in level of service, while two intersections actually see an improvement in LOS. This improvement in LOS can be directly attributed to the new Third Harbor Tunnel. All but five of the 16 analysis intersections provide LOS "C" or better.

Six study intersections experience a decline in LOS in the evening peak hour from existing to No-Build while one slightly improves (in terms of V/C ratio). In the PM peak, eight of the 16 study intersections operate at LOS "C" or better.

The Build level of service results presented in Tables 6.1-18 and 6.1-19 are based on the addition of full project volumes to the No-Build network. As a result, project impacts may be overstated because existing site-related traffic was not subtracted out to obtain net additional traffic. This was not done because limited on-site parking and the presence of relatively inexpensive off-site parking on the Fan Pier may result in many site generated trips going to an off-site location. As a result, the impact of existing site related traffic on streets near the site is uncertain. In order to avoid possibly underestimating project impacts, no reduction of existing traffic was made on the network. The only analysis for which net project volumes were used was the Central Artery analysis of regional congestion points which are known to be affected by site related traffic regardless of its specific Downtown destination.

The addition of project-related traffic to 1994 No-Build volumes results in only one study intersection experiencing a decline in LOS. The Oliver Street/Purchase Street intersection will decline from LOS "B" to LOS "C" in the morning peak hour and from LOS "A" to LOS "B" in the evening peak hour.

At four of the five intersections projected to operate at LOS "E" or "F" in the AM peak hour under 1994 No-Build volumes, the addition of project traffic will have limited or no impact on volume-to-capacity (V/C) ratio. The greatest impact will be at the Surface Artery/High Street/Atlantic Avenue intersection where the V/C ratio will increase by 0.29. At the Atlantic Avenue/ Northern Avenue intersection, an increase of only 0.01 will be

experienced. There will be no change in V/C ratio at the intersections of Congress Street with High Street, or Atlantic Avenue or at Pearl Street/High Street.

In the evening peak hour, at the eight intersections projected to operate at LOS "E" or "F" under No-Build conditions, the addition of project traffic, as in the morning peak, will have limited or no impact. The largest increase in V/C ratio will be at the Congress Street/Purchase Street intersection where an increase in V/C of 0.13 will be experienced. Some increases will be felt at the intersections of Congress Street/Atlantic Avenue and Surface Artery/High Street/Atlantic Avenue, where the V/C ratios will increase by 0.06 and 0.05, respectively. The remaining five intersections, Summer Street/South Street/High Street, Summer Street/Atlantic Avenue, Congress Street/Franklin Street, Congress Street/High Street and Atlantic Avenue/Northern Avenue, will experience no change in V/C ratio.

In terms of actual volume, the largest project impacts would be at the Oliver Street/Purchase Street intersection in the morning peak hour and at the Pearl Street/Purchase Street intersection in the evening peak hour. In the morning, the project will add an estimated 436 additional vehicles through the Oliver Street/Purchase Street intersection all on Purchase Street. In the evening, the project will add an estimated 445 vehicles to the intersection of Pearl Street/Purchase Street, again, all on Purchase Street. Due to the lack of conflicting volumes at the intersection of Pearl Street/Purchase Street, only the additional morning volumes at the Oliver Street/Purchase Street intersection will have any impact on delay and congestion at these locations.

The City is currently in the process of reviewing plans providing for the optimization of approximately 250 traffic signals in the Downtown area. The program involves the installation of a central computer to monitor traffic flow and select

appropriate traffic signal phasing and timing based on demand measured at local intersections. The computer portion of the program has been bid by the Massachusetts Department of Public Works, with the local intersection improvements expected to be bid within several months. Completion of the work is expected by the time of full occupancy of One Twenty Five High Street. This improvement program is expected to have a major impact on improving operations at individual intersections throughout the system.

Central Artery Impacts

The purpose of this section is to present the additional volumes that background development and One Twenty Five High Street will contribute to critical Central Artery congestion points. The two congestion point locations presented are the high level bridge over the Charles River at the junction of I-93 and Route 1 and the Massachusetts Avenue interchange south of downtown. At both locations, existing congestion defines capacity. Currently, there are plans under way to replace the existing I-93/Route 1 interchange with a multi-level, fully directional interchange. This will result in increased capacity at this location and a reduction in the congestion that results from the limitations of the current interchange. However, even with the proposed improvements, this location will remain a limiting point in the overall capacity of the Central Artery.

Table 6.1-20 lists the net additional morning inbound volumes and evening outbound volumes from the development which will be approaching these locations in the peak hour. The morning approach to the high level bridge is the total of vehicles approaching from both I-93 and Route 1 (Tobin Bridge). From the table, it can be seen that the Massachusetts Avenue congestion point will experience a volume increase of approximately three

times that experienced by the high level bridge. The increases in Artery volumes from One Twenty Five High Street range between 6 and 7 percent of the total peak hour Artery increases.

TABLE 6.1-20
CENTRAL ARTERY PEAK HOUR VOLUME INCREASES

Time/Location	Volume Increase: 1994 Build Condition Background	Project	Total	Project Increase as Percent of Total Increase
Morning Inbound				
-- High Level Bridge	960	74	1,034	7.2%
-- Massachusetts Ave.	3,218	201	3,419	5.9%
Evening Outbound				
-- High Level Bridge	1,101	76	1,177	6.5%
-- Massachusetts Ave.	3,171	205	3,376	6.1%

The additional Artery volumes from the development will increase queues and delays at the Artery congestion points. In the morning peak hour, the project will add approximately 25 vehicles per lane inbound at the High Level Bridge and almost 70 vehicles per lane inbound at Massachusetts Avenue. These volume increases result in an average increased delay for all vehicles of less than one second at the High Level Bridge and of approximately 1.5 seconds at the Massachusetts Avenue interchange. The average additional delay to all vehicles is small because of the relatively small contribution of project traffic to total traffic. Increased volumes, queues, and delay outbound in the evening will generally be the same as inbound in the morning at the respective congestion points.

The congestion points are currently operating at capacity and are expected to continue operating at capacity. This means that

stop and go traffic and existing levels of service will continue. Because these points are at capacity, additional peak hour demands will result in longer queues and increased delay.

In order to determine the extent of the impacts that One Twenty Five High Street is expected to have on ramp merges onto the Central Artery, four key intersections within the study area were examined. These intersections include Atlantic Avenue/ Northern Avenue, Congress Street/ Purchase Street, Congress Street/Atlantic Avenue and High Street/Surface Artery. All are immediately upstream of ramps leading onto the Artery. Only two of these intersections are affected by project volumes entering the Central Artery. In the evening peak hour, a total of approximately 390 project generated vehicles are projected to travel southbound onto the Artery via the Congress Street/ Purchase Street intersection and approximately 140 vehicles are expected to travel northbound after passing through the Congress Street/Atlantic Avenue/Northern Avenue and High Street/Surface Artery are not expected to be utilized by outbound evening peak hour traffic from One Twenty Five High Street. In the morning, the project will contribute only minor volumes to the two ramps impacted in the evening.

Currently, the southbound on-ramp at Purchase Street and Congress Street and the northbound on-ramp at Congress Street and Atlantic Avenue are at or near capacity as indicated by constant queuing in the evening peak hour. The Artery itself is also operating at capacity. As a result, Level of Service "F" conditions prevail for the ramp merges and merging takes place in a stop and go pattern with vehicles in the right travel lane of the Artery. The addition of project volumes will add to the queue lengths and increase delay. The 140 project generated vehicles headed northbound will increase average delay to all vehicles on

the ramp by almost 20 seconds, while the 3 percent project generated vehicles on the southbound ramp would increase average delay to all vehicles on that ramp by almost 3-1/2 minutes. It should be noted that these projections somewhat overstate the project impacts as existing site generated traffic on these ramps was not subtracted from total future volume to obtain net additional traffic. As described earlier, this was not done because of uncertainty regarding the parking location and routing of existing site generated traffic. This analysis does not assume any shifting of ramp volumes to other nearby upstream or downstream ramps.

These additional volumes could have adverse impacts on the respective upstream intersections by causing backups toward the intersection which would slow vehicles exiting the intersection. In the case of the more heavily impacted southbound ramp, mitigating factors include the presence of a merging/weaving lane between the on-ramp and the next downstream off-ramp, and the presence of a nearby alternative on-ramp upstream adjacent to International Place. The impact on the northbound ramp is only a third of that on the southbound ramp.

6.1.3.8 Impacts of Other Transportation Projects

This section is designed to consider qualitative impacts of project-related traffic on the roadway network if any of several major roadway improvements should be implemented. Four such sets of improvements have been considered. These include Alternatives A and B from the Dewey Square Comprehensive Transportation Systems Management (TSM) Program, proposed access improvements to South Boston across the Fort Point Channel, and the Depressed Central Artery. In addition, a discussion is included which focuses on how the 1994 Build networks would be changed if the High Street off-ramp from the Central Artery is not relocated to Purchase Street.

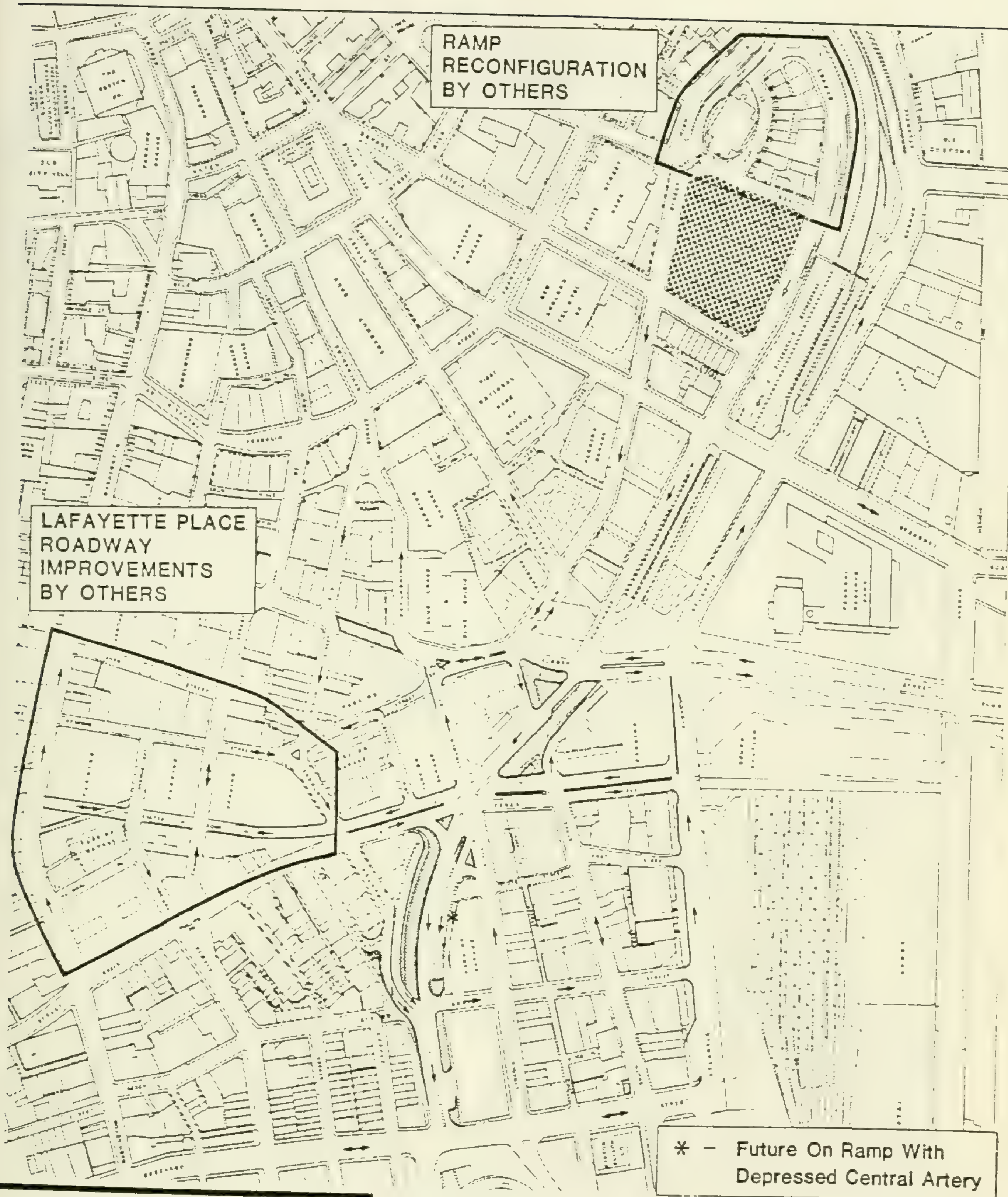
Dewey Square TSM Alternative A

The primary changes envisioned for Alternative A (Figure 6.1-14) for the Dewey Square Program include making the Surface Artery one-way southbound between Summer and Kneeland Streets and making Essex Street two-way between Atlantic Avenue and Kingston Street. This system would not result in significant changes in routes to and from the site. Inbound traffic would continue to approach the site along Purchase Street from the High Street/Atlantic Avenue intersection while outbound traffic would use Purchase Street to reach the Central Artery on-ramp, Congress Street (to Atlantic Avenue) and Pearl Street. Therefore, few if any changes in estimated impacts would result from implementation of this alternative.

Dewey Square TSM Alternative B

Alternative B (Figure 6.1-15) is similar to Alternative A, but with some additional changes. These changes include making High Street one-way northbound between Summer Street and Atlantic Avenue; making Summer Street one-way eastbound between Lincoln Street and High Street; eliminating the short eastbound segment of Summer Street between High Street and Purchase Street; and closing South Street between Summer Street and the Surface Artery. Alternative B would have an effect on the level of service at particular study intersections.

As can be seen in Table 6.1-21, which is a condensed version of the level of service tables which appear in the Dewey Square TSM study, eight of the intersections within the One Twenty Five High Street study area have also been analyzed under proposed Alternative B conditions. It should be noted, however, that the results for 1987 existing conditions from the Dewey Square report, although similar, are not directly comparable to the level of service results for existing conditions presented in



Dewey Square TSM Alternative A Roadway Network

LEGEND

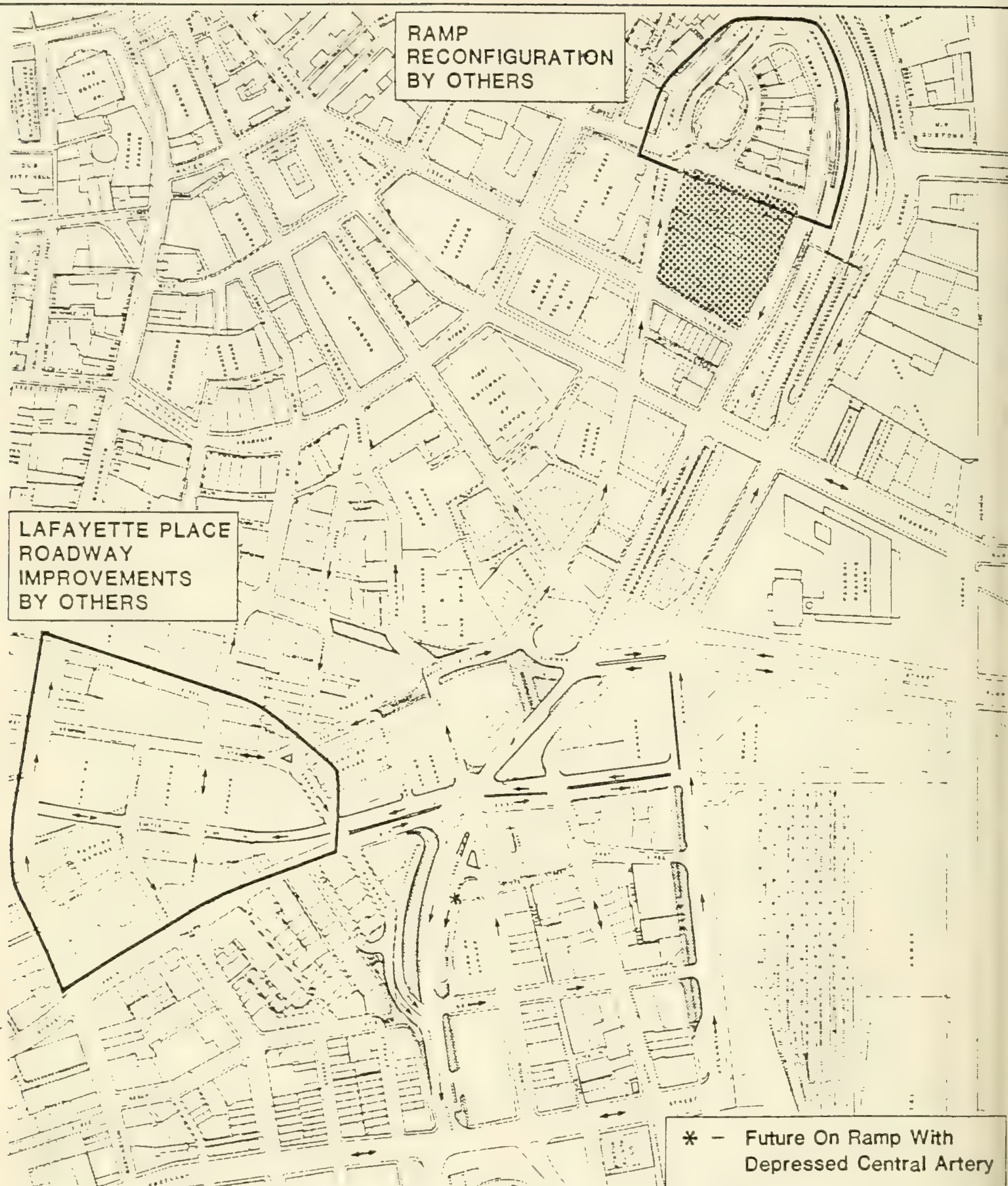
Site

Vanasse/Hangen
Consulting Engineers & Planners
60 Birmingham Parkway Boston MA 02135

SCALE: 1"=Approx. 400'

Fig. 6.1–14

1602/487/wpr



Dewey Square TSM Alternative B Roadway Network

LEGEND

Site

Vanasse/Hangen
Consulting Engineers & Planners
60 Birmingham Parkway, Boston, MA 02135

SCALE: 1"=Approx. 400

Fig. 6.1-15

this report due to the different analysis techniques and background traffic volumes utilized in each report. This comparison is simply meant to suggest what type of impacts may result due to the shifts in volume which would occur under Alternative B.

TABLE 6.1-21
INTERSECTION LEVEL OF SERVICE WITH AND WITHOUT
DEWEY SQUARE ALTERNATIVE B IMPROVEMENTS

	1987 Conditions Without Alternative B				1987 Conditions With Alternative B			
	AM		PM		AM		PM	
Intersection	V/C	LOS	V/C	LOS	V/C	LOS	V/C	LOS
Summer/South/High	0.58	A	0.63	B	0.35	A	0.15	A
Summer/Purchase/ Surface	0.55	A	0.52	A	0.58	A	0.74	C
Summer/Atlantic	1.00	F	0.90	E	1.03	F	0.88	D
High/Federal	0.65	B	0.58	A	0.38	A	0.16	A
Congress/High	0.52	A	0.63	B	0.27	A	0.55	A
Congress/Purchase	0.82	D	0.91	E	1.00	F	1.06	F
Congress/Atlantic	0.87	D	0.90	E	0.92	E	0.94	E
Pearl/High	0.55	A	0.28	A	No signal		No signal	

The impact of the Dewey Square Alternative B improvements on the One Twenty Five High Stsreet intersections west of High Street and north of Congress Street, not included in the Dewey Square Study, will result primarily from the reversal of High Street. This reversal would result in southbound High Street volumes being diverted to Purchase and Franklin Streets. This would likely result in reduced levels of service at most locations on these streets. The opening of High Street to northbound traffic would be expected to divert traffic from Atlantic Avenue resulting in generally improved levels of service.

The Dewey Square report states that with the implementation of Alternative B roadway improvements, four intersections are projected to undergo a decline in operating conditions. The intersections of Summer Street/Purchase Street/Surface Artery, Congress Street/Purchase Street and Congress Street/Atlantic Avenue are all expected to experience an increase in V/C ratios or a drop in level of service in both the morning and evening peak hours. In the AM peak, the intersection of Summer Street/ Atlantic Avenue undergoes an increase in V/C ratio, although conditions improve at this location in the PM peak. All other intersections examined in both the Dewey Square and One Twenty Five High Street study areas experience an improvement in conditions and all are projected to operate at LOS "B" or above.

Certain travel paths to and from the site would also be effected because of the reversal of the direction of flow along High Street. Inbound traffic from the northwest along Storrow Drive and Memorial Drive could approach the site more directly via Congress Street, High Street and Oliver Street. With the existing southbound flow on High Street, somewhat more circuitous routes via Milk Street/ Broad Street/Surface Artery or via Milk Street/Batterymarch Street/High Street/Oliver Street must now be made. Because only 9 percent of incoming traffic is projected to arrive along these routes, however, the impact of the High Street reversal on morning peak hour project traffic would be minor.

Outbound traffic from the site would receive a significant benefit from the reversal of High Street. Under the current pattern, all northbound traffic must travel south via Purchase Street to Congress Street, east on Congress Street and north on Atlantic Avenue or the Central Artery. Evening peak hour outbound traffic thus requires traveling through the congested Atlantic Avenue/Northern Avenue intersection. With the reversal of High Street, northbound project traffic could reach the

Surface Artery via High Street and avoid the congestion along Atlantic Avenue south to High Street. Impacts along Atlantic Avenue from International Place would also be substantially reduced with the reversal of High Street.

South Boston Access

The major improvement in South Boston access across the Fort Point Channel will be the replacement and relocation of the Northern Avenue Bridge. Although this improvement will result in better and more reliable access to South Boston, it will have little impact on travel patterns to and from the project or on conditions at study area intersections. The only exception to this will be the intersection of Northern Avenue and Atlantic Avenue which will be signalized and will have a different configuration. Because of the relocation of Northern Avenue south of its existing alignment, its intersection with Atlantic Avenue will occur at the same location where the northbound Central Artery off-ramp intersects Atlantic Avenue.

A more significant improvement in terms of impact on downtown locations is a proposed people mover between South Station and the World Trade Center. Such an improvement would generally serve to remove traffic from downtown streets and thereby contribute to improved operating conditions. This proposal is still in the early planning stages and an evaluation of its impacts on traffic is difficult. The initial concept appears to be for a monorail that would shuttle back and forth between the World Trade Center and the South Station area. There has been a suggestion that some intermediate stops may be possible but no specific locations are proposed. The people mover would not provide any direct service to One Twenty Five High Street unless it crosses the Central Artery.

Depressed Central Artery

One Twenty Five High Street has been designed to be compatible with the Depressed Central Artery. The design was developed in consultation with the Massachusetts Department of Public Works (MDPW) and the I-90/I-93 Project consulting engineers. It provides for a 32-foot wide Purchase Street along the entire block between Oliver Street and Pearl Street. This width is based on the location of the portal for the Purchase Street off-ramp as fixed by the Central Artery design team.

The project design provides for an easement adjacent to the Purchase Street right-of-way in order to allow sufficient room for the 32-foot roadway. The building has been set back from the roadway to provide this easement. Included within this easement will be the sidewalk which will be under a building arcade. Sufficient curbside space will be allowed outside the building arcade to accommodate any needed signing along the street. The Purchase Street cross section will provide for two 11-foot travel lanes and a 10-foot right-turn lane for turns from Purchase Street to Pearl Street. The two travel lanes will align with the two downstream travel lanes in the block south of Pearl Street.

The assessment of the potential impact of the Depressed Central Artery on traffic conditions is based on the Preferred Alternative (5A Modified) presented in the Final EIS for the Third Harbor Tunnel/Central Artery project. The major features of that design with regard to study area roadways are making the Surface Artery one-way between Summer Street and Kneeland Street (similar to the Dewey Square TSM improvements); making the Central Artery's South Station tunnel one-way southbound except for one contra-flow on-ramp lane northbound which would begin at Essex Street; moving the northbound Central Artery to a new tunnel under the Fort Point Channel; providing an extension of

Oliver Street across the Artery with two lanes eastbound; relocating the Purchase Street off-ramp to join Purchase Street at Pearl Street; and providing a crossing of the Artery at Pearl Street that allows southbound U-turns from the new Purchase Street off-ramp to Atlantic Avenue and northbound left turns from Atlantic Avenue to Pearl Street.

Travel paths to and from the site would change considerably with the Depressed Central Artery. Inbound traffic from the south and west (along the Massachusetts Turnpike) could no longer take the Artery and exit at High Street and Atlantic Avenue because that exit will be eliminated. Instead, traffic from the south and west would most likely exit along New Dorchester Avenue, turn westbound on Congress Street and then northbound on Atlantic Avenue. This would add project traffic to the Atlantic Avenue intersections at Congress Street and Northern Avenue.

Another significant shift would be for inbound traffic from the north. The shift of the Purchase Street off-ramp's location to Pearl Street would put the exit south of the project garage entrance. Because of the one-way street pattern in the area, traffic from the north would have to exit the Artery earlier and approach the site on the Surface Artery. This would have the effect of increasing project impacts along the Surface Artery at the Broad Street and High Street intersections.

Outbound travel patterns would be little affected by the Depressed Central Artery. Traffic to the south and west would continue to use the Purchase Street southbound on-ramp. Traffic to the north would U-turn across the Artery at Congress Street and use the northbound High Street on-ramp instead of the existing on-ramp at Congress Street. The only change results from the closure of the northbound Congress Street on-ramp which would add project traffic to the Atlantic Avenue/Northern Avenue intersection.

The effect of these shifts on levels of service is not assessed in this document. However, in general, the depression of the Central Artery can be expected to improve levels of service on surface streets since considerable increases in through capacity will be provided, along with additional opportunities to cross the Artery.

High Street Off-Ramp Relocation

As part of the second phase of development of International Place, the southbound High Street off-ramp is proposed to be relocated to Purchase Street (prior to the Depressed Central Artery and at a different exit point than described above). Because the full development of International Place is proposed to be completed by 1990, the relocation of the ramp has been assumed in the development of 1994 networks. The relocation of the ramp has only a minor effect on inbound traffic from the north. With the relocated ramp, traffic from the north will exit directly onto Purchase Street from which it would enter the garage. Without the ramp relocation, this traffic would exit onto High Street, turn eastbound on Oliver Street and southbound on Purchase Street. This shift would have only a minor effect on the two Oliver Street intersections at High Street and Purchase Street in the morning peak hour.

6.1.3.9 Transit Analysis

Rapid Transit

The proposed project is expected to generate an approximate net increase of 1,798 outbound pubic transportation trips in the evening peak hour. Based on the 1982 Cordon Counts for Downtown Boston, 70 percent of public transportation trips are made by rapid transit. Therefore, a total of 1,259 outbound rapid

transit trips can be expected to be generated by the proposed development. As described earlier, a considerable level of background growth due to other area development is also anticipated. The assignment of background and project rapid transit trips is shown in Table 6.1-22. This assignment is based on each line's share of total rapid transit ridership in 1984.

Orange and Blue Line passengers, as well as northbound commuter bus and commuter rail riders, will enter the rapid transit system at State Station. Blue Line riders may also board the system at Aquarium Station. Red Line commuters are expected to use South Station, and Green Line passengers are expected to board the Red Line at South Station and transfer at Park Street.

TABLE 6.1-22
ASSIGNMENT OF RAPID TRANSIT TRIPS
GENERATED BY PROJECT AND BACKGROUND DEVELOPMENT
PM PEAK HOUR

Line/Direction	Project Percent Distribution	Project Trips	Background Trips*	Total Trips
Red/North	12	151	2,098	2,249
Red/South	23	290	4,394	4,684
Green/West	17	214	3,069	3,283
Green/North	2	25	368	393
Orange/North	20	252	4,215	4,467
Orange/South	14	176	2,942	3,118
Blue/North	12	151	2,497	2,648
TOTAL	100	1,259	19,583	20,842

* Rapid transit trips generated by all downtown, Back Bay, and South Boston background development identified in the traffic analysis. Also includes impacts of Cambridge development served by the Red Line.

Rapid Transit Improvements

Several rapid transit improvements are underway with completion anticipated well before 1994. These include relocation of the Orange Line and increased capacity on all four lines.

The Southwest Corridor Project involves the relocation of the Orange Line south of Essex Station and the expansion of platforms and trains from four to six cars. The segment involved is approximately 4.7 miles in length and includes eight new stations. The MBTA plans to operate six-car trains at 4.5-minute headways; the current Orange Line fleet is more than adequate for this plan.

Red Line improvements include platform lengthening, station modernization, acquisition of new cars, renovation of existing cars, and track reconstruction. As a result of these improvements, especially the platform lengthening and acquisition of new cars, the MBTA plans to operate six-car trains at currently scheduled frequencies, resulting in a line capacity increase of 50 percent.

The MBTA budget for fiscal year 1988 calls for an increase in Blue Line capacity to 20 outbound train trips in the PM peak hour. The existing rolling stock is more than adequate to meet this schedule. Since each train has a planning capacity of 440, the resulting planning capacity of the line will be 8,800.

The Green Line is also scheduled for improvements in capacity. One hundred new LRVs, scheduled for delivery by the end of 1987, will alleviate current equipment shortages and improve system performance. Expansion of certain station platforms and upgrading of the power system will allow the use of three-car trains.

The projected future volumes and planning capacities with improvements in place are shown in Table 6.1-23. Projected Build volumes generally represent an almost 2 percent increase over the No-Build volumes. In general, background volumes are expected to generate about a 37 percent increase over existing volumes.

Under Build conditions, the Orange Line will operate under capacity in the southbound direction and over capacity northbound during the evening peak hour based on six-car trains and 4.5-minute headways. Under Build conditions, the Green Line north segment would operate under capacity, while the Green Line west segment would be over its combined planning system capacity for all branches. With the planned expansion of the Red Line trains to six cars, this line will operate under capacity. The Blue Line will operate under capacity as well.

On the Green Line/West, the projected Build ridership of 13,283 is 4 percent greater than the forecast planning capacity of 12,740. While this situation is not ideal, it represents a substantial improvement upon existing conditions. As shown in Table 6.1-2 above, Green Line/West ridership currently exceeds planning capacity by 33 percent.

On the Orange Line/North, the 19 percent excess of Build ridership over forecast planning capacity is not surprising, considering that the capacity forecast is calculated from the 4.5-minute headways that will be in place in 1987, while the Build ridership will not occur before 1994. There is every reason to expect that the MBTA will respond to ridership growth on the Orange Line as it occurs. The 120-car Orange Line fleet is already large enough to operate four-minute headways. With four-minute headways, the excess of Build ridership over capacity would be just 6 percent, an improvement upon the current excess of 10 percent, shown in Table 6.1-2 above. With 12 additional

TABLE 6.1-23
1994 TRANSIT VOLUMES AND CAPACITIES
PM PEAK HOUR OUTBOUND

Line/Segment	Existing*	No-Build Volume	No-Build Percent Increase	Build Volume	Build Percent** Increase	Line Capacity***
Red Line/North Ashmont-Alewife Braintree-Alewife (Charles)	7,140	9,238	29.4	9,389	1.6	16,200
Red Line/South Alewife-Ashmont Alewife-Braintree Park-Quincy (Andrew)	11,190	15,584	39.3	15,874	1.9	17,280
Green Line/West Total of All Lines (Arlington)	10,000	13,069	30.7	13,283	1.6	12,740
Green Line/North Lechmere Service (Science Park)	1,100	1,468	33.5	1,493	1.7	2,600
Orange Line/North Forest Hills- Oak Grove (North Station)	10,270	14,485	41.0	14,737	1.7	12,400
Orange Line/South Oak Grove-Forest Hills (Essex)	7,080	10,022	41.6	10,198	1.8	12,400
Blue Line/North Bowdoin-Wonderland (Aquarium)	6,120	8,617	40.8	8,768	1.8	8,800

* All existing ridership figures are for the peak direction at the peak station (in parentheses) in the peak hour.

** Percent increase in 1994 Build vs. 1994 No-Build.

*** Projected Red Line capacity is based on six-car trains operating at existing observed headways. Orange Line capacity is based on six-car trains operating at slightly increased headways (4.5 minutes) based on current MBTA plans. Blue Line capacity is based on the 20 outbound trips in the PM peak hour budgeted for Fiscal Year 1988. Green Line West capacity is based on 24 3-car trains and 13 2-car trains in the peak hour. The passenger capacity of each car is based on figures used by the MBTA for planning purposes. Heavier loads can be carried and are often observed on the system.

cars, Orange Line headways could be improved to 3.75 minutes which would bring planning capacity up to the level of Build ridership. Acquisition of new Orange Line cars is currently under discussion at the MBTA.

The impact of project and background trips on northbound Red Line trains between South Station and Park Street was assessed to determine whether this segment would become the peak load segment for northbound trains in the PM peak hour. It was determined that the project would add about 390 trips to this segment while background developments would add about 1,710 trips, for a total of 2,100 new trips. Since this total is less than the 2,250 new trips which will be added to the Red Line's north segment, the downtown segment will not become the critical link ("peak load segment") for northbound trains. Northbound Build ridership in the downtown area will be less than the 9,400 level forecast for the Red Line/North, which in turn, is only 58 percent of forecast planning capacity.

Express Bus

Almost one-quarter of the project-generated public transportation trips are expected to be by bus (414 in the evening peak hour). Five express routes operated by the MBTA provide service between the Financial District and suburban areas along the Massachusetts Turnpike. Express bus service is also available from Haymarket to North Shore communities. Private commuter bus service to the South Shore is provided at South Station. Local bus service is limited and has not been analyzed.

The MBTA maintains a policy that reduces the potential for standees by releasing buses when seats are filled in order to maintain the high level of ridership. This includes adding buses

to the express routes as needed. Clearly, as a result of this project and other background developments, demand increases will require additional express bus service to be provided.

6.1.3.10 Pedestrian Analysis

Pedestrian trips generated by One Twenty Five High Street can either be considered as transit-related or non-transit related. Most pedestrian trips generated by the project will be transit-related (i.e., walking to rapid transit stations or bus stops). In the morning peak hour, a net increase of 1,776 transit-related pedestrian trips is expected, while a net increase of 1,798 transit-related pedestrian trips is expected in the evening peak.

The majority of transit-related pedestrian trips can be expected to use Purchase Street south of the site for access to South Station via the new Red Line portal at the northwest corner of Summer Street and Atlantic Avenue, and High Street south of the site for access to the express bus stop on Federal Street or the Washington Street MBTA Station. Blue Line passengers were assumed to use Purchase Street north of the site and Pearl Street west of the site for access to the Aquarium or State Street Stations, respectively.

Non-transit-related pedestrian trips are defined to be strictly walking trips (i.e., the entire trip is made by walking and no other mode of travel is used for any portion of the trip). An approximate net increase of 1,127 non-transit pedestrian trips a day is expected to be generated by the project. However, only small percentages of these daily non-transit-related trips occur in the morning and evening peak hours. In the AM peak, a net increase of only 36 walk trips is projected, while in the PM peak, only 56 new walk trips are projected to occur.

From this discussion, it can be seen that the project will generate a net increase of 1,812 pedestrian trips in the morning peak and a net increase of 1,854 pedestrian trips in the evening peak. In order to assess the impact of project-generated pedestrian volumes on the sidewalks adjacent to the site, as well as expected background pedestrian volumes from the International Place Development, which is currently under construction, standardized analysis techniques were applied.

The 1985 Highway Capacity Manual (Special Report 209 by the Transportation Research Board) provides an approach for defining levels of service based on the sidewalk space provided to pedestrians. Briefly, this analysis procedure for walkways is based on peak 15-minute pedestrian counts taken at a specific study location, usually a midblock walkway. The physical characteristics of the sidewalk itself are then closely examined, namely the width of the sidewalk and the presence of obstacles, such as street furniture (fire hydrants, light poles, mail boxes), landscaping (shrubs, trees), and building protrusions (awning poles, columns, driveways). Effective sidewalk width is then determined by subtracting the unusable width (that portion of the sidewalk where an obstacle is located) from the total sidewalk width. Using the peak pedestrian flows and effective sidewalk width, pedestrian unit flow rates for average and platooning conditions are then calculated in pedestrians per minute per foot (ped/min/ft). Levels of service for these conditions are then found by comparing the resulting flow rates to the criteria found in Table 6.1-24.

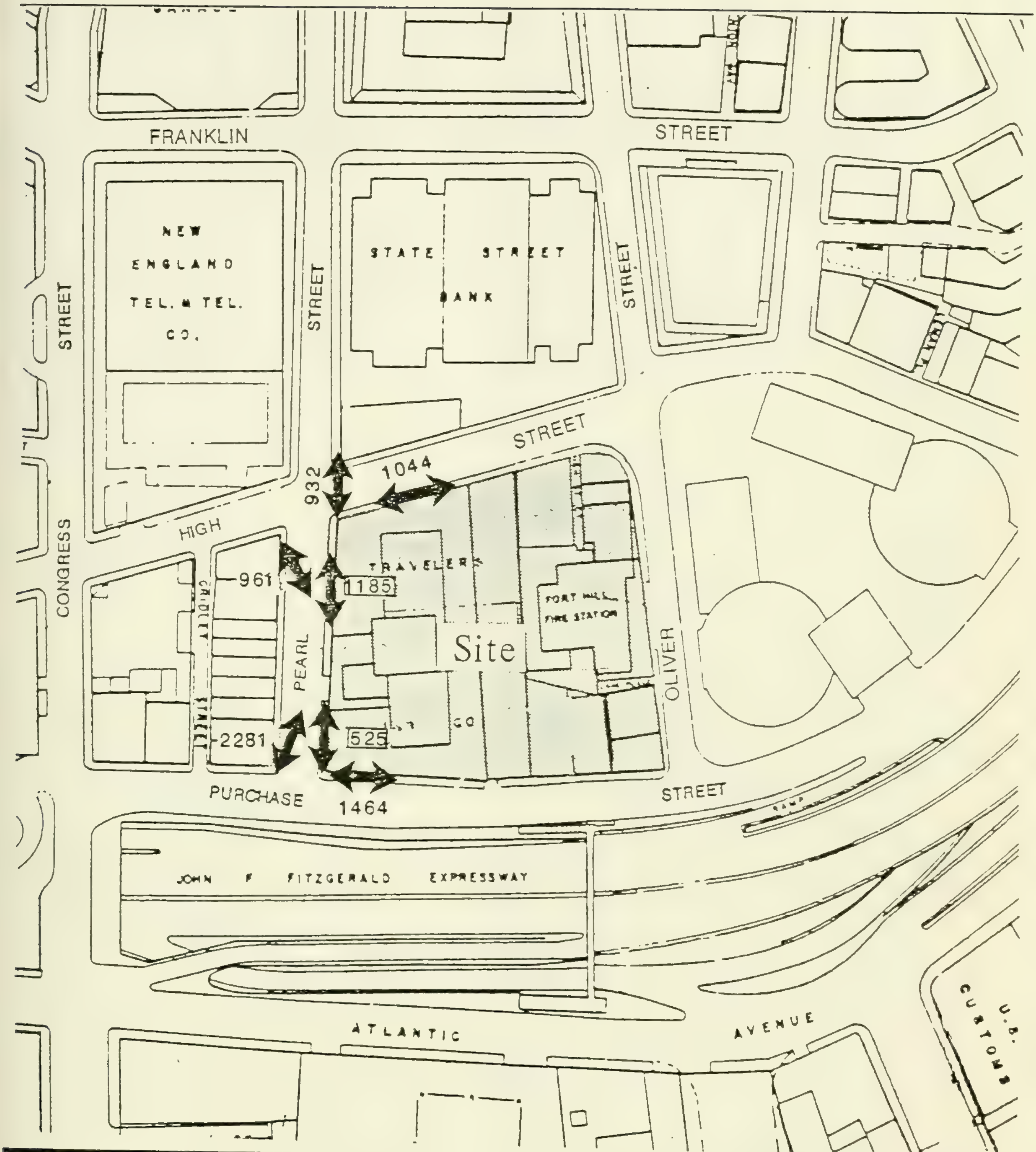
As can be seen in the table, a ranking system from A to F, similar to vehicular levels of service, is provided for walkways and for pedestrian queuing areas. Level of Service "A" within a walkway affords pedestrians the opportunity to move in desired paths without altering movements in response to other pedes-

trians. Level of Service "F" is characterized by frequent unavoidable contact with other pedestrians. In Level of Service "C", sufficient space is available to select normal walking speeds and bypass other pedestrians in primarily one-way streams. In Level of Service "D", the selection of individual walking speed becomes restricted as well as the ability to bypass other pedestrians.

TABLE 6.1-24
PEDESTRIAN LEVEL OF SERVICE CRITERIA ON WALKWAYS

		Expected Flows and Speeds		
Level of Service	Space (SF/Ped)	Average Speed (Feet/Min)	Flow Rate (Ped/Min/Ft)	V/C Ratio
A	≥130	≥260	≤2	≤0.08
B	≥40	≥250	≤7	≤0.28
C	≥24	≥240	≤10	≤0.40
D	≥15	≥225	≤15	≤0.60
E	≥6	≥150	≤25	≤1.00
F	≥6	≥150	-- Variable --	

Most of the project-generated pedestrian trips, as indicated earlier, will be bound for either bus or transit stops. Peak load areas in the vicinity of the site include South Station, the Federal Street express bus stop, the Washington rapid transit station, and either the State or Aquarium rapid transit stations. Utilizing downtown public transit distribution figures, Table 6.1-25 summarizes AM and PM generated pedestrian volumes associated with these peak load areas. The total volumes were then distributed accordingly to the street, sidewalk and arcade areas at the proposed site. The result of the addition of these project-generated pedestrians to the existing pedestrian volumes observed at the site in the Pearl Street study area can be seen in Figures 6.1-16 and 6.1-17. Also, background pedestrian trips from International Place have been distributed and routed as



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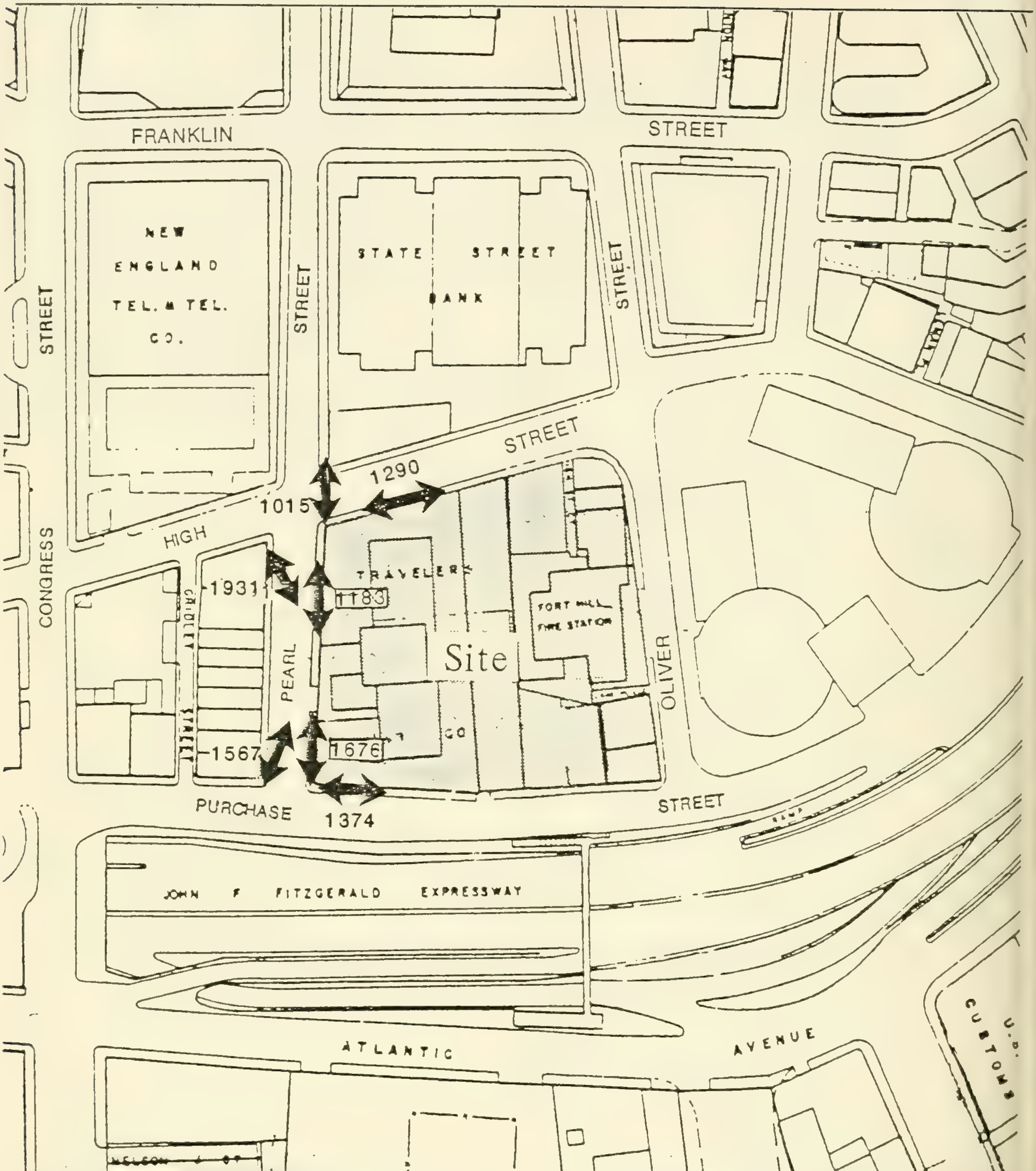
1994 Build A.M. Peak Hour Pedestrians Volumes

SCALE: 1"=Approx. 150'

Fig. 6.1-16

1602/487/wpr



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1994 Build P.M. Peak Hour Pedestrians Volumes

SCALE: 1"=Approx. 150'

Fig. 6.1-17

found in the International Place FEIR. The addition of these background volumes, where appropriate, is also reflected in the resulting volumes found in the figures.

TABLE 6.1-25
DISTRIBUTION OF PROJECT GENERATED
PEDESTRIAN VOLUMES TO AREA LOAD POINTS

Load Point	Percentage	Pedestrian Volumes AM	Pedestrian Volumes PM
South Station	41%	743	760
Federal Street Express Bus Stop or Washington MBTA Station	39%	707	723
State Street or Aquarium MBTA Stations	20%	362	371
Totals	100%	1,812	1,854

Table 6.1-26 summarizes the results of the pedestrian analysis at four key sidewalk and arcade area locations to be constructed around the proposed site. These specific locations were chosen for analysis since large percentages of the pedestrian trips to be generated by the site pass these points. The proposed project calls for the construction of sidewalks which have effective widths of 9 feet, 11 feet and 12.5 feet on High Street, Pearl Street and Purchase Street, respectively. These widths were the values used in the pedestrian level of service analysis. From the table, it can be readily seen that the sidewalk and arcade areas at One Twenty Five High Street will easily accommodate projected pedestrian flows. (The pedestrian level of service analysis worksheets can be found in Appendix A.)

TABLE 6.1-26
1994 BUILD PEDESTRIAN
LEVEL OF SERVICE ANALYSIS RESULTS

Location	Average Walkway Level of Service	
	AM	PM
High Street east sidewalk at Pearl Street	A	B
Pearl Street north sidewalk at High Street	A	A
Pearl Street north sidewalk at Purchase Street	A	B
Purchase Street west sidewalk at Pearl Street	A	B

6.1.3.11 Parking

One Twenty Five High Street includes the provision of approximately 850 parking spaces, of which 30 are to be reserved for the Boston Fire Department, seven for a Boston ambulance facility and 150 for public use, thus leaving approximately 663 spaces for the project's tenants. Fifty of the 150 public spaces will be reserved for short-term use and the rate structure for all the public spaces will be designed to encourage short-term use. Access to/from the garage will be via a driveway on Purchase Street. Two loading docks with approximately nine bays will also be provided inside the building with access via the garage driveway on Purchase Street. There will be sufficient room inside the building to accommodate the required truck turning movements internally so there will be no stopping or backing onto Purchase Street.

Parking Demand

The 1,390,000 square foot office plus retail development program analyzed for traffic impacts will generate the need for 1,015 long-term employee spaces (all day commuter parking) based on trip generation factors previously detailed. These factors assumed that 30 percent of the building's employees arrive via auto with an occupancy rate of 1.8 persons per vehicle. The short-term demand from building visitors is approximately 265 spaces and was calculated using a turnover rate of 2.67 cars per space per day taken from Parking in Central Boston. The turnover rate was applied to the number of non-work trips arriving at the site. Under these assumptions, the total daily parking demand will be 1,280 spaces.

The results of the analysis indicates that even with a total parking supply of 850 spaces, the project's on-site parking would be unable to accommodate the entire projected demand for the site. Table 6.1-27 indicates a total shortfall of 467 spaces, including a deficit of 352 spaces for long-term parkers and 115 for short-term parkers.

It should be recognized that this shortfall represents a somewhat conservative analysis of conditions within this portion of the Financial District. The assumed 30 percent automobile use factor is one which is average in an area which is not as readily served by transit and where adequate, reasonably priced parking is provided. As noted earlier in the trip generation section, a review of parcels near the development site suggests a mode split of only 20 percent auto use may be possible.

TABLE 6.1-27
PROJECT PARKING SUPPLY/DEMAND SUMMARY

Parking Component	Supply	Demand	Surplus or (Deficit)
Long-Term			
Existing Site	105	286	(181)
Net New	558*	729	(171)
Future Total	663*	1,015	(352)
Short-Term			
Existing Site	0	67	(67)
Net New	150**	198	(48)
Future Total	150	265	(115)
Total			
Existing Site	105	353	(248)
Net New	708*	927	(219)
Future Total	813*	1,280	(467)

* Excludes 30 spaces to be set aside for the Boston Fire Department, and seven spaces for a Boston ambulance facility.

** Fifty public spaces are to be reserved for short-term use, while all the public spaces will be priced to encourage short-term use.

Applying this 20 percent automobile use rate to employee trips results in the need for 683 long-term spaces. With the general trend of 20 percent auto usage within the immediate area, the net provision of 813 spaces may be more consistent with long-term parking demand. As with long-term demand, short-term parking may also be overstated as a large number of walk trips from within the Financial District may be expected by visitors to the site.

It should be noted that if a shift should occur away from autos to transit for work-related trips, the increased transit demand will still be below transit system capacity, except on the Orange Line North, the Blue Line North, and the Green Line West.

The previously noted small rate of transit increase from the project would still describe the expected magnitude of project impacts.

In order to assess the net impact of the parking deficit created by the proposed project, parking for the existing Travelers Building was also examined. As can be seen in Table 6.1-26, the site's existing uses conservatively generate the need for 286 long-term spaces and 67 short-term spaces. However, on-site parking is presently limited to only 105 spaces, thus creating an existing deficit of 248 spaces. Therefore, under conservative analysis conditions, the net parking deficit created is only 219 new spaces (467 total deficit spaces less 248 existing deficit spaces).

6.1.3.12 Construction Impacts

Construction Employee Trip Generation and Parking

The number of workers required over the five-year construction period will vary, but it is estimated that the peak at any given time will not be more than 630 workers. Trip generation by construction workers is a direct function of employment levels. Assuming an auto occupancy of two or three persons (based on the shortage of parking, current costs of parking, and the greater inclination of construction workers to carpool), the 630 employees during the peak construction period would generate from 210 to 315 trips each peak period if all employees commute by automobile. However, the construction management consultant retained by the developers to advise them on construction-related matters indicates that they expect at least half of the construction workers to utilize public transportation due to the downtown location of the site and its good accessibility via transit. In addition, construction workers generally travel before the peak

hours (working 7:00 AM to 3:30 PM), so their impacts on commuter peak hour traffic are further reduced. As a result, no significant impact to the area roadway system is anticipated from construction worker vehicle-trips during the peak commuter hours.

No parking will be available on-site for construction workers. Therefore, the construction workers who do drive will park in available public spaces in area lots or garages or at more remote locations and walk to the site. This situation is common for most large downtown construction projects. There have been and will continue to be a large number of ongoing construction projects in the Downtown area. In the early years of the project's construction, some workers may park at the Fan Pier in South Boston because of the relatively high daily cost of off-street parking in the immediate area. This factor may also encourage lower auto use and higher transit usage.

Street Closures/Lane Restrictions

Areas on the periphery of the site will be used for unloading construction materials. A loading dock for the 30-story building may be provided on Pearl Street near Purchase Street for materials which can be transported via the on-site hoist. Because it is a relatively low volume one-way street, it appears that the choice of Pearl Street versus High or Purchase Streets will have a beneficial impact on traffic flow. The hoist/unload area for the 21-story building may be on Oliver Street near High Street.

No street closures are currently expected to be required during project construction. Lane restrictions that will be necessary for delivery vehicles include the Pearl Street, Purchase Street, and Oliver Street curb lanes adjacent to the site. All are currently used by drivers who illegally park on

these streets (even though peak period parking prohibitions are in effect). As a result, there will be no loss of travel lane capacity due to construction activity. If the High Street off-ramp is relocated while construction is still ongoing, the existing parking restriction on the south side of Pearl Street will have to be enforced to allow two through lanes into Downtown for traffic exiting the Central Artery at the relocated High Street off-ramp. Until the ramp is relocated, it will be necessary to insure that Oliver Street also remains unobstructed to accommodate existing off-ramp traffic. The prohibition on parking (Tow Zone designation) on the south (Fire Station) side of Oliver Street should be continued and enforced. No blockages of any existing travel lanes appear to be necessary on any streets adjacent to the site.

Construction Vehicle Routing

The exact source locations of construction materials are not known at this time, but it is expected that all deliveries will access the site via the Central Artery and Surface Artery. For construction of the 30-story building, deliveries from the north are expected to exit the Central Artery at the High Street off-ramp and proceed to the site via Oliver, Purchase and Pearl Streets. For later phases of construction, once the High Street ramp is closed or relocated, it will be necessary for construction vehicles to exit at the Haymarket off-ramp and proceed to the site via the Surface Artery, High Street and Oliver Street. Deliveries from the south will exit via the Central Artery off-ramp at High Street, then make a U-turn at the High Street/ Atlantic Avenue/Purchase Street intersection and use Purchase Street to reach Pearl Street, during construction of the 30-story building, or High Street to Oliver Street during the construction of the 21-story building. Return trips to the north will be via

the Atlantic Avenue on-ramp to the Central Artery north of Congress Street, while southbound trips will use the Purchase Street on-ramp to the Central Artery south of Congress Street.

6.1.3.13 Fire Station Accessibility

The existing Fort Hill Fire Station located on Oliver Street will be relocated and incorporated into the new structure. It will have access onto Purchase Street immediately south of the garage access. This location will assure that vehicles slowing to enter the garage will not interfere with fire trucks exiting the fire station. A 45-foot apron will be provided between the street and the fire station doors. This apron, in conjunction with the provision of three lanes on Purchase Street, will provide adequate space to maneuver entering and exiting fire trucks.

6.1.4 Access Plan

6.1.4.1 Demand Reduction/Management Strategies

Reducing the amount of traffic generated is an effective alternative to simply providing the roadway improvements necessary to satisfy projected traffic growth. Much can be done to reduce automobile usage and thereby lessen the need for improvements or provide for the more efficient use of any improvements provided. The following describe measures designed to reduce the number of vehicle-trips into the project area. All have been discussed with the proponent and with the single largest tenant, the New England Telephone Company (NET), which currently has many of these measures in place. Both have committed to implementing them in so far as it is within their ability to do so.

Ridesharing

Ridesharing is an overall term that refers to encouraging commuters to ride in vehicles with other commuters rather than driving to work alone. The most common forms of ridesharing are carpools and vanpools. Increased ridesharing means that fewer vehicles will be using the roadways, with the result that there will be less congestion. An additional benefit will be reduced fuel consumption, as fewer vehicle miles will be traveled.

Carpooling and vanpooling programs are best implemented at the company level with a designated administrator to oversee the program. The proponent and major tenant of this project (NET) are committed to the following incentives:

1. Provision of on-site carpool/vanpool matching programs.

2. Participation in joint programs with other nearby tenants, organizations, and companies.

3. Provision of promotional materials on ridesharing to employees.

4. Inclusion of promotional information on ridesharing in a building newsletter for tenants, which will provide flexibility in disseminating information and aid in matching potential poolers.

5. Coordination with Caravan (an organization which leases commuter vans and provides administrative and organizational assistance) or other van leasing programs. NET strongly supports Caravan by having a representative on the Board of Directors and by contributing in the past to help Caravan acquire its computer facility.

Public Transportation

Another major way to reduce the number of vehicles on the roadways is to encourage employees to use mass transit instead of driving to work. The proposed project site is located within walking distance of South Station commuter buses and trains, the express bus stops in the Financial District, and the Red, Orange and Blue Lines. This provides an excellent opportunity for the project to generate high transit usage. The proponent will encourage transit usage through the following measures:

1. Provision of an on-site location for sale of MBTA passes and private bus line tickets.

2. Encouraging tenants to subsidize a portion of their employees' public transportation costs.

3. Provision of bus, commuter rail and commuter boat schedules.

4. Provision of promotional and informational materials for all forms of public transportation.

Alternative Work Schedules

Alternative work schedules offer a way to reduce peak hour demands on the roadway system and on transit systems by shifting travel to non-peak hour periods or by reducing the total amount of travel per week. The major alternatives are:

a. Staggered work hours - Generally are set up in such a way that groups of employees are assigned staggered starting times, typically at 15-minute intervals, spread over a one or two-hour period.

b. Flexible work hours - Allows employees to choose their own starting and finishing times, as long as they are present during a central part of the day (called core time).

c. Compressed work weeks - Involves shifting some workers from a standard five days per week, eight hours per day schedule to fewer days of longer hours (e.g., four days per week, ten hours per day).

The proponent and/or the major tenant (NET) are committed to the following measures:

1. In accordance with its current policy, NET has already established a flex-time system with a required core time of 9:00 AM to 4:00 PM.

2. Encourage other tenants to do the same during the lease negotiation process.

3. As an incentive for other tenants, the proponent will make building services such as heat, air conditioning, etc., available during "off-hours" at no marginal cost penalty if tenants shift employee start/end times.

Parking Supply Management

The development's parking supply will be managed to encourage reduced peak hour traffic. Measures which would accomplish this include:

1. Provision of one vanpool parking space for each 50,000 square feet of building space, or room for up to 27 vanpool vehicles for project tenants.

2. Preferential treatment for carpool and vanpool vehicles.

3. Placing restrictions on use of the project's available public parking supply so as to promote short-term use by visitors, shoppers, business persons, etc.

4. Access to the parking facility will be via a three-lane driveway which will feature one lane inbound, one lane outbound and a center reversible lane to accommodate peak directional flows. The gates and collection equipment will be set back approximately 230 feet from Purchase Street to prevent queuing onto the street.

Delivery Vehicles

1. Provision of sufficient off-street loading/unloading space (approximately nine bays) for all delivery vehicles, including bicycle messengers, to minimize the amount of this activity on-street. Access to the loading area will be from Purchase Street and sufficient room for truck maneuvering will be provided internally. As a result, no stopping or backing will be necessary on-street to accommodate trucks.

2. Encourage all tenant delivery vehicles (with the exception of courier services) to use off-peak hours, which include all times other than 7:00-10:00 AM and 3:00-6:00 PM weekdays.

3. Require major tenant deliveries (which typically require the moving of furniture, etc.) to be made before 7:00 AM or after 6:00 PM weekdays.

4. Provision for 24-hour off-street loading by appointment to encourage off-hours deliveries.

5. Prohibition of off-street deliveries to the buildings from any location other than the loading dock. No deliveries will be accepted through the main entrances to the buildings.

6. Items 4 and 5 will reduce turnover time for delivery vehicles (a dockmaster will supervise delivery activity) and improve security for delivery services if they use the off-street facility.

7. Collection boxes for major courier services will be located in areas convenient to the loading dock. Courier services will be required to use the loading dock and drop-offs/pickups will not be accepted at other locations, thereby minimizing impact on street traffic.

Taxis

1. At present, the closest major taxi stand is located on Franklin Street between the State Street Bank and the Meridien Hotel. With this project and International Place, it is projected that the demand for taxi service will increase significantly. As a result, the proponent will work with the City to provide a taxi stand waiting area at a mutually agreed upon location, most likely on High or Pearl Streets.

2. Taxi drop-offs would occur at any of several building entrances around the site, but primarily on Pearl and High Streets.

Pedestrians

Good pedestrian linkages should be available between the project and the main activity areas surrounding the site. Important connections include the following:

a. Over the Central Artery via the existing pedestrian footbridge to Atlantic Avenue and the waterfront,

b. Along Purchase Street toward Dewey Square and South Station,

c. Along High Street toward Dewey Square,

d. Across High Street toward Government Center and the Quincy Market area.

Therefore, the following improvements are proposed to enhance existing pedestrian amenities in the project area:

1. Good crosswalk markings are provided only at the High Street/Pearl Street intersection and across Purchase Street at the footbridge. As part of the construction of the project, the proponent will improve/replace crosswalk markings at the other adjacent intersections to the site. The intersection of High and Oliver Streets is currently being upgraded by others.

2. All locations surrounding the site except the High Street/Pearl Street intersection and the Purchase Street crosswalks at the footbridge are lacking full pedestrian amenities, including pushbuttons and Walk/Don't Walk signal indications. These intersections will be investigated for the possible addition of pedestrian crossing

signals. It is also proposed that the High Street/Pearl Street location be evaluated for potential modifications to pedestrian signal timing and phasing. The proponent will cooperate with the City in providing pedestrian amenities at these locations. However, these improvements are assumed to be implemented by the City as part of its ongoing signal system upgrading program.

3. Appropriate levels of street lighting will be provided on all sidewalks surrounding the site.

4. The proponent will work with the City to further investigate the feasibility of renovations to or replacement of the existing pedestrian footbridge over the Central Artery.

<u>Other</u>

1. A secure bicycle storage area for use by employees who wish to commute via bicycle will be provided within the project.

2. The project proponent will appoint a staff person in the building management office whose responsibilities will include the coordination of all of the above efforts. This Transportation Coordinator will be the City's key contact with the building management and will have the authority to resolve transportation issues as they arise.

<u>Access Goals</u>

1. In the impact analysis section, estimates were made for several factors which, when combined, resulted in the project's estimated contribution to vehicle trip and

transit trip loadings on the study area transportation systems. Three such factors are the most significant in terms of this end result. They are:

- o Percent transit use (person trips to/from the project by all forms of public transportation)
- o Vehicle occupancy rate (number of people in each vehicle driving to/from the project)
- o Peak hour percentage (the portion of daily trips to/from the project which occur during the AM or PM peak hour)

To minimize vehicular travel, it would be desirable if the first two factors were higher than assumed and the third factor lower than assumed. This serves as the basis for establishing a set of access goals for the project, as shown in Table 6.1-28. The table lists each of the three factors, or measures of effectiveness, along with the value estimated in the impact analysis, the Access Plan feature that will try to improve the factor, and the goal set for each factor after implementation of the Access Plan at full project buildout and occupancy. Also listed is another factor, the placement of public parking supply reserved for short-term use, which has an impact on parking supply/demand relationships. The lower portion of the table summarizes the AM and PM vehicle trips and transit person trips estimated for the original impact analysis factors and for the new factors which will be the goals. It should be noted that all figures in the table refer to office work trips, which constitute about 89 percent of the project's vehicle trip generation and 92 percent of its transit trip generation during the

peak commuting hours. Peak hour trips shown in the table represent the net new trips generated by the project, i.e., total trips less existing trips now being generated by the buildings occupying the project site.

2. As a follow up to the setting of goals, the proponent will provide annual management reports to the City on compliance with the stated objectives as well as other elements of the Access Plan.

3. The proponent also commits to work with the City to address any other transportation-related issues.

TABLE 6.1-28
ACCESS GOALS

		Analysis Estimate	Mitigation Action	Goal
A. Trip Generation Factors				
Percent by Transit		70%	Transit Incentive	75%
Vehicle Occupancy Rate		1.8	Ridesharing	2.0
Peak Hour Percentage		55%	Alternative Work Hours	50%
Percent Public Parking Reserved for Short-Term		0%	Reserve Portion for Short-Term	33%
B. Resulting Net New Peak Hour Trips				
Vehicle Trips:	AM in	389		215
	PM out	389		215
Transit Trips:	AM in	1,636		1,576
	PM out	1,636		1,576

6.1.4.2 Construction Management

An important component of the Access Plan is an effective series of measures designed to minimize traffic flow and safety impacts during the construction phase. Summarized below are several measures which are expected to be incorporated into the construction management plan for the project. Final details of the plan will be worked out when a construction contractor is selected for the project. The summary listing is as follows:

1. Secure fencing, staging and bracing will be provided around the entire block to protect pedestrian traffic near the construction site. The existing sidewalk on High Street will have a protective covering. Safe crossings will be provided to relocate pedestrian traffic to the opposite side of all other streets.

2. An on-site staging area for construction materials is to be initially located in the northeast corner of the site at High and Oliver Streets, then relocated to the new garage after its completion of the 30-story building. Storage will be handled within the garage itself.

3. Use of the adjacent curb lane is required on Purchase, Pearl and Oliver Streets for unloading of construction delivery trucks. Use of these lanes will not affect vehicle capacity since they are currently used for illegal peak hour parking. The hoist/unloading area for the 30-story building will be at the Pearl Street/ Purchase Street corner. A similar area for the 21-story building will be at the Oliver Street/High Street corner of the project.

4. No blockage of existing travel lanes will be permitted on any street at any time.

5. Police control will be used at key locations as required to facilitate traffic flow, insure pedestrian safety, and prevent blockage of the relocated fire station driveway on Purchase Street by construction vehicles.

6. Construction worker parking will not be permitted on-site or adjacent to the construction area. All construction workers will be required to access the site by public transportation, ridesharing, or by parking at off-site locations.

7. Worker shifts will be scheduled so as to minimize conflict with the typical commuting periods.

6.1.4.3 Roadway Improvements

The project's size characteristics, excellent location with respect to public transportation services, and the proponent's proposed commitment to various demand/reduction strategies all will result in relatively small traffic impacts at the key locations analyzed. Nevertheless, the proponent recognizes the desirability of improving traffic circulation within the financial district so as to maximize efficiency of traffic flow to/from the project site and has committed to work with the City to support implementation of improvements, including the proposed Transportation Systems Management program for Dewey Square.

As a result of this study, certain intersection improvements have been identified which will improve volume-to-capacity ratios and reduce congestion. Improvements are delineated below for the four intersections which will be impacted by the project and will

operate at LOS "F" under Build conditions. All of these locations will also operate at LOS "F" under No-Build conditions. It should be noted that an additional five intersections which would operate at LOS "E" or "F" under Build conditions are not considered in this discussion because they are not impacted by the proposed development and would not change from the No-Build to Build condition.

- Congress Street/Purchase Street - Improvement at this intersection involves providing the curb parking lane on the southbound approach of Purchase Street for travel. Although not improving overall intersection LOS, the use of this lane would reduce intersection delay and the V/C ratio on the southbound approach in the PM peak hour from 1.54 to 1.05. Traffic generated by the proposed project will utilize this approach in the evening peak hour.

- Congress Street/Atlantic Avenue - Operating at LOS "F" in both the morning and evening peak hour periods, V/C ratios at this intersection could be improved and delay reduced by making the curb parking lanes on both Atlantic Avenue and Congress Street westbound available for traffic in the peak hours. This would result in a reduction in the morning V/C ratio from 1.40 to 1.04 and in the evening V/C ratio from 1.28 to 1.14. This improvement has also been identified in the Fan Pier/Pier 4 Final EIR.

- Atlantic Avenue/Relocated Northern Avenue - Changes in the proposed new signalized intersection of Atlantic Avenue/Relocated Northern Avenue would result in improvements of LOS in both the morning and evening peak hours. In the AM peak, LOS would change from "F" to "D", while in the evening peak, LOS would change from "F" to "E".

These changes, which have also been identified in the Fan Pier/Pier 4 Final EIR, involve providing the curb parking lane on Atlantic Avenue for peak hour traffic, construction of a triangular traffic island to provide channelization for northbound right turns, and striping the Central Artery off-ramp for two-lane operation for a distance of 100 feet back from the intersection. The proposed island would allow eastbound ramp volumes headed for Northern Avenue to move concurrently with northbound rights while northbound throughs are stopped. With these proposed improvements, intersection delay would be reduced and V/C ratios would decline from 1.65 to 1.33 in the morning peak and from 1.44 to 0.95 in the evening peak.

- High Street/Atlantic Avenue/Surface Artery - As noted in the Fan Pier/Pier 4 FEIR, no operational improvements are possible, because full use is already made of all available lanes. Improvements can only be achieved through extensive reconstruction such as will occur with the depression of the Central Artery. It should be noted, however, that circulation changes proposed in the Dewey Square TSM study could have a positive impact on the High Street/Atlantic Avenue/Surface Artery intersection with regard to project as well as International Place traffic. The Dewey Square study found that by reversing the traffic flow on High Street from its current southbound direction to northbound, positive impacts would occur from a traffic circulation perspective in the Financial District. The study found that only by relocating the High Street off-ramp to Purchase Street did the reversal work most effectively.

The reversal of High Street could also benefit the intersection of High Street/Atlantic Avenue/Surface Artery in the AM peak hour. Volumes bound for One Twenty Five High Street or International Place which would exit the Central Artery at High Street in order to gain access to Purchase Street, could, with the reversal of High Street, exit the Central Artery earlier. Project and International Place traffic could exit the Expressway at Kneeland Street and proceed up South Street to High Street. Once on High Street, project traffic could gain access to One Twenty Five High Street via Oliver Street to the Purchase Street entrance. International Place traffic could turn right from High Street onto Purchase Street. A shift of project and International Place traffic due to the reversal of High Street would result in a significant reduction in the approach volume from the Artery off-ramp. The net effect of this shift would have to be evaluated in conjunction with other volume shifts at the intersection and the impact of adding another approach into the signal control.

In conjunction with the above noted intersection improvements, a more generalized arterial improvement has been identified for Atlantic Avenue. Currently, parking is permitted along Atlantic Avenue between South Station and State Street. The intersections at Summer Street, Congress Street and Relocated Northern Avenue will operate at deficient levels in 1994. All locations would have improved V/C ratios with the restriction of parking and provision of an additional travel lane in the peak hours. As was successfully done by the Boston Transportation Department with Congress Street, all peak hour parking along Atlantic Avenue from Summer Street to State Street should be restricted and an additional travel lane should be provided. State Street is proposed as the northern limit of the parking

restriction because it has been identified by the City, along with Atlantic Avenue, as a future traffic-management street similar to Congress Street. The effects of this arterial improvement at the Congress Street and Relocated Northern Avenue intersections along Atlantic Avenue have been noted above. At Dewey Square (Summer Street) the removal of parking on Atlantic Avenue in addition to the removal of parking of the westbound Summer Street approach would result in a decline of the morning V/C ratio from 0.87 to 0.79 and in the evening V/C ratio from 1.03 to 0.88. This arterial improvement has also been identified in the Fan Pier/Pier 4 FEIR.

It should be noted that the future V/C ratios and projected improvements in V/C ratios given in this report may differ somewhat from those reported in the Fan Pier/Pier 4 Final EIR. This results, in part, from the fact that a different analysis technique was used for this report. As previously mentioned under the Traffic Operations Measures section of this report, the methodology utilized in this study to determine intersection capacities and the resulting levels of service is taken from the 1985 Highway Capacity Manual (HCM). Basically, the new technique and that previously utilized from the Transportation Research Circular 212 are both based on the analysis of the critical movements within an intersection. However, unlike the methodology found in Circular 212, the new HCM procedure explicitly takes into account various factors which were generally assumed under the older technique. These factors include approach grades, arrival types, lane widths, lost time per phase, peak hour factors, signal controller type, signal timing and truck and bus traffic. The methodology used in this study, which directly takes into account many of the operational and physical aspects of an intersection previously assumed, yields somewhat more accurate results than those obtained following the procedure presented in Circular 212.

Another source of differences is the fact that two separate networks were used. The One Twenty Five High Street volumes are part of a balanced downtown network, while the Fan Pier/Pier 4 volumes are part of a balanced South Boston network. As a result, there is some variation in projected volumes between the networks.

6.2 WIND

6.2.1 Summary of the Quantitative Studies

This section provides a summary of the two quantitative studies presented in Section 6.2.2 and 6.2.3. The latter of these studies was carried out to evaluate the effects of various design changes in the development and therefore those results are emphasized here. The following points summarize the two quantitative studies:

- Three site configurations have been examined; namely, before development, after the 30-story building development has been completed, and after full development has been completed (see Figures 6.2-1 through 6.2-4 for the first study and Figures 6.2-15 through 6.2-17 for the second study).

- Quantitative measurements of winds at pedestrian level have been carried out in a simulated atmospheric wind using a rigid 1:500 scale model of the site and its surroundings. A total of 35 locations have been examined in the first study and 32 in the second study. Many locations were common to all 3 configurations and both studies. A complete range of wind direction at 10° intervals has been investigated.

- The locations tested were based on the results of the previous sand scouring study (Section 6.2.1) of the site so they tend to reflect not only the more important pedestrian areas around the site, but also the areas expected to be windiest. In the second study, some locations were added on Oliver Street in order to better understand the wind conditions there.

In general, the windiest area around the site is along Oliver Street, but even there the wind speeds are between speeds expected in a typical suburban environment and those expected in an open country environment. Other areas around the site rarely exceed wind speeds typical of a suburban environment. Wind speeds near the entrances of the new development are particularly low. Winds on the walkway across the Central Artery and opposite the walkway on Purchase Street are decreased.

- Experimental results of mean and gust speed have been combined with statistics of the full-scale wind climate to provide predictions of the speeds expected for 1% of the time, and the rate of occurrence of certain mean speeds. These can be compared with acceptance criteria for pedestrian comfort, as developed by Davenport and Melbourne.

- The general level of windiness around most of the site is not significantly changed by the development; most areas are slightly less windy, some slightly more. Gust wind speeds expected to be exceeded 1% of the time on an annual basis do not exceed 30 mph at any of the locations examined for the most recent site configurations. No locations fall into Melbourne's unacceptable category. Two locations at the corner of Pearl and Purchase Streets, where increased windiness is attributable to the new development, are well within acceptable limits for the likely pedestrian activities in this area.

- The windiest area is at the southernmost end of Oliver Street, near International Place. This area is windy prior to the addition of One Twenty Five High Street, particularly for southeasterly winds that are amplified by the International Place towers; for other wind directions, this area is relatively sheltered.

- The first study indicated that the addition of One Twenty Five High Street would increase speeds somewhat in Oliver Street. The second study, however, showed that with the new geometry, speeds were decreased at most locations over the speeds present with the former geometry. Furthermore, the new locations along Oliver Street, which were placed on the sidewalk, indicated lower speeds than previous locations that were placed in the roadway. The arcade along this street would also be expected to provide more shelter on windy days.

6.2.1.1 <u>Stage I - Qualitative Study</u>

<u>Summary of the Findings of a Wind Tunnel Sand Scour Test</u>

The purpose of this study was twofold:

- To qualitatively evaluate the impact of One Twenty Five High Street on wind speeds at pedestrian level by comparing the windiness of the existing site with the redeveloped site; and

- To determine the best locations for placing measurement instruments for a further test to determine actual wind speeds.

This dual purpose led to the testing of three site configurations: the current site, the 30-story building, and the complete development including both the 30-story and 21-story buildings. Figures 6.2-1 to 6.2-4 show diagrams and photos of these site configurations.*

The site has been the subject of a previous study aimed at determining the impact on pedestrian level winds of various possible massings for the development of the site (Ref. 1, p. 6.2-23). The current design has adopted a preferred massing based on those previous results and also reflects additional features aimed at protecting the pedestrian level environment, such as placing the buildings on a podium where possible. This allows the downwardly-directed winds on the windward face to escape around the building at the top of the podium rather than at street level.

6.2.1.2 Study Methodology

Models of the various site configurations were built to scale. The model and wind tunnel study techniques are detailed in the quantitative analysis section of this chapter. Photos of the experimental test conditions are shown in Figure 6.2-5.

The methodology for performing a sand scour study is as follows: sand of uniform grain size is sprinkled evenly over the site. The wind is then turned on and its free stream speed increased to the speed of interest. The wind then scours the sand away from the areas where the local wind speed exceeds the speed necessary to lift the sand (i.e., areas that are scoured first are the areas with the highest wind speed). After an

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NOTE: This chapter was prepared by Dr. D. Surry and Mr. G.R. Lythe of the Boundary Layer Wind Tunnel Laboratory, The University of Western Ontario, London, Ontario.

*All figures are displayed at the end of this chapter beginning on p. 6.2-31.

equilibrium state is reached where the sand has stopped moving (in this case, after 2 minutes), the scour pattern is recorded and the wind speed is increased to the next speed of interest and the process is repeated. In this experiment, the primary recording medium was videotape, from which the still pictures displayed in this report were taken. The videotape retains higher quality and a copy was submitted to the BRA staff on September 29, 1986 for review.

The free stream wind speeds of interest were chosen on the basis of a preliminary test for winds from the west. In this test, the wind speed was slowly increased until the first scour patterns were seen. This speed (30 feet per second) was chosen as the main speed of interest with a speed somewhat less (24 fps) and a speed somewhat more (40 fps) also used. For some other wind angles, where the site was more open, an additional, lower speed (20 fps) was used. At some other wind angles, where the site was particularly sheltered, an additional, higher speed (45 fps) was used. Note that the numerical values for the free stream speed have no direct significance in relation to quantifying the wind speeds at the site since the initial scour speed was uncalibrated; however, the ratios of the free stream speeds are significant. Moreover, the relative windiness of the three configurations tested are assessable through the relative sand scour results. This is a useful method to compare designs.

Tests were performed for all three site configurations for five wind directions: winds from the east, northeast, south, southwest, west, and northwest. The basis for choosing these wind directions was the wind climate for Boston. Two models for the wind climate of Boston have been developed in conjunction with the previous study of this site; one is based on wind records measured at upper level and the other is based on surface wind speed measurements at Logan Airport. Figures 6.2-6.a and 6.2-6.b show that the directionality associated with these two wind climate models for return period of one week and one month are very similar. These return periods are those likely to be of importance for considering the wind environment.

This relative importance factor gives the percent contribution of each sector of 22.5° surrounding the indicated azimuth. It can be seen that wind is most likely to come from westerly directions (about 25% of the weekly wind events come from a 22.5° sector containing west) and is very unlikely to come from southeasterly directions. Also noted on this figure are the directions chosen for this study. It can be seen that the directions chosen cover 85% to 90% of the winds in Boston.

6.2.1.3 Results

Visual results of the test are shown in Appendix B-1. The following observations can be made from these figures. The approximate percentage of the time that the wind is within 45° of the chosen direction is indicated in brackets; 45° is consistent with the azimuthal spacing of the directions tested.

1) Northwest Winds (approx. 25%):

- o The site is very sheltered.
- o Wind conditions improve when the site is developed.
- o The windiest locations are near the corners of buildings.

2) West Winds (approx. 35%):

- o Wind conditions are improved when the site is developed.
- o The pedestrian arcades are completely sheltered from high winds.

3) <u>Southwest Winds (approx. 15%)</u>:

- o The northwest corner of the site becomes somewhat windier after development.

- o Wind conditions elsewhere around the site are improved after development.

- o Winds going around the two western corners of the 30-story building go through the pedestrian arcade.

4) <u>South Winds (less than 10%)</u>:

- o The site is exposed for this direction and hence is windier than for other directions.

- o The site is not any windier after development than before, with the exception of Pearl Street.

- o Except for the southern corner, the pedestrian arcade is completely sheltered from high winds.

5) <u>East Northeast Winds (approx. 10%)</u>:

- o The site is exposed for this wind angle.

- o The site is not any windier after development than before except for a little on High Street.

As a result of observing the flow through the northwest corner of the pedestrian arcade for southwest winds, several attempts at ameliorating this condition were made by slightly altering the corner geometry. The first change made was to cut off the corner under the overhang. The results are shown in Appendix B-1, Figure B-16, where it can be seen that this change

has had little effect. The second change made was to seal the first five openings between the columns along Pearl Street, starting at the corner of Pearl and High Streets, as well as the first three openings along High Street, in addition to the cut-off corner. The results are shown in Appendix B-1, Figure B-17, where it can be seen that this change has been effective in reducing the flow through the arcade.

As noted earlier, the current site configuration has been previously studied quantitatively. Included in Appendix B, Figure B-18, is a figure from that report showing the results of that study. The results in this figure can be used in conjunction with the sand scour patterns to approximately determine the absolute windiness of the three configurations. Note that the current results are quite consistent with the trends in these previous results.

The net conclusion of the comparisons is that the project tends to improve the environmental wind conditions for the most common wind directions and that even for less common directions there are only a few isolated locations whose conditions deteriorate. These are still likely to remain less severe than the present windiest locations on the site. The follow-up quantitative study, described below, was performed to verify these conclusions.

Based on the results of this study, the locations noted in Figures 6.2-7a, 6.2-7b, and 6.2-7c were selected in cooperation with the BRA for quantitative measurements. These locations have been chosen for several reasons. Some locations highlight the windier areas, some are located near entrances, some are located off the site for reference, and some duplicate positions used in reference 1.

6.2.2 Stage II - Quantitative Study

6.2.2.1 Introduction and Summary

This section presents the results of a study of the pedestrian level wind environment in the vicinity of One Twenty Five High Street. It includes tests on 3 site configurations; namely, before development, after the 30-story building has been completed, and after the full development has been completed.

As noted earlier, this site has been the subject of two previous studies. The first was aimed at determining the impact on pedestrian level winds of various possible massings for the development of the site. The second study was a sand scour investigation aimed at qualitatively determining the impact of the current design on the pedestrian level winds with a view to determining the best locations for making the quantitative measurements in this study. This study was presented in the previous section. In addition, International Place, opposite the site on Oliver Street, has also been the subject of a previous study, undertaken by J.A. Peterka and J.E. Cermak. Some comparisons with that study are made here.

Quantitative measurements of winds at pedestrian level have been made at a total of 35 locations (see Figures 6.2-7a, 6.2-7b, and 6.2-7c) for the three configurations. Many of the locations are common to more than one configuration, in order to directly evaluate the impact of the proposed project. Other locations are particular to the environment of the project itself, chosen on the basis of the previous sand scour study summarized above. All measurements have been taken over the complete azimuth range at 10° intervals.

In Section 6.2.2.2, the overall approach adopted by the Boundary Layer Wind Tunnel Laboratory is discussed, including both wind tunnel test procedures and the use of full-scale wind data in combination with wind tunnel results. In Section 6.2.2.3, the experimental procedures followed and the aerodynamic results are discussed. In Section 6.2.2.4, the statistical predictions of the environmental winds are presented.

The following points summarize the quantitative study:

A) Three site configurations have been examined; namely, before development, after the 30-story building development has been completed, and after full development has been completed (see Figures 6.2-1 through 6.2-4).

B) Quantitative measurements of winds at pedestrian level have been carried out in a simulated atmospheric wind using a rigid 1:500 scale model of the site and its surroundings. A total of 35 locations have been examined, many of which were common to all 3 configurations. A complete range of wind direction at 10° intervals has been investigated.

C) The locations tested were based on the results of the previous sand scouring study (Section 6.2.1) of the site so they tend to reflect not only the more important pedestrian areas around the site, but also the areas expected to be windiest.

D) Experimental results of mean and gust speeds have been combined with statistics of the full-scale wind climate to provide predictions of the speeds expected for 1% of the time, and the rate of occurrence of certain mean speeds. The latter can be compared with acceptance criteria for pedestrian comfort, as developed by Davenport (Ref. 3).

E) The general level of windiness around most of the site is not significantly changed by the development; some areas are slightly less windy, some slightly more. Wind speeds are particularly low near the entrances of One Twenty Five High Street. The windiest area is at the southernmost end of Oliver

Street, near International Place. This area is windy prior to the addition of One Twenty Five High Street, particularly for southeasterly winds that are amplified by the International Place towers; for other wind directions, this area is relatively sheltered. The addition of One Twenty Five High Street appears to exacerbate conditions in this local area near the southernmost International Place tower. Providing shelter for this area for southeasterly wind directions appears difficult, although trees or other wind breaks on the northeast corner of Oliver and Purchase Streets may be of some help.

F) For all locations examined, the 1% speeds rarely exceed those that would be expected in a typical suburban environment. In the windiest areas, the wind speeds expected 1% of the time are between those expected in a typical suburban environment and those expected in a typical open country environment.

6.2.2.2 Overall Approach

The essence of the approach adopted by the Boundary Layer Wind Tunnel Laboratory is the combination of model measurements with statistics of the full-scale wind climate to provide predictions of the expected wind environment at street level. This process is detailed elsewhere (Refs. 5, 6, 7, and 8); however, two important aspects should be noted. First, the experimental determination of the wind speeds at model scale requires a valid simulation of the atmospheric boundary layer, including the correct representation of the strength and size of the turbulent eddies -- ususally denoted the intensity and scale of the turbulence -- and the correct representation of the change in mean speed with height above ground. Secondly, the combination of the wind speed measurements with the full-scale wind climate statistics is considered the most meaningful way to

interpret the overall nature of the resulting pedestrian level climate. For example, a wind direction found to produce strong pedestrian level winds in the wind tunnel is more significant if that wind direction occurs frequently in full scale. The predictions presented in this report, such as the rate of occurrence of certain pedestrian level wind speeds, reflect the degree of coincidence of wind directions producing high wind speeds at pedestrian level (as determined from the model study) with the likelihood of such full-scale wind directions occurring (as determined from historical records).

The basic tool used in the study was the Laboratory's Boundary Layer Wind Tunnel, in which the model is shown mounted in Figures 6.2-4 and 6.2-5. The wind tunnel is designed with a very long test section, which allows extended models of upwind terrain to be placed in front of the model of the building under test. The wind tunnel flow then develops characteristics which are similar to the wind approaching the actual site. This methodology has been highly developed and is detailed elsewhere (Refs. 8,9,10).

In this case, rigid models of the 30-story and 21-story buildings were constructed to a scale of 1:500. This scale is determined by the properties of the wind tunnel boundary layer in relation to those of the real atmospheric wind. Figure 6.2-4 shows some close-up views of the three model configurations.

The site was centered within a detailed model of the immediate surroundings. This proximity model extended for a full scale radius of 2,000 ft. It was built to best approximate the surroundings when One Twenty Five High Street is completed. In this way, the impact of the project itself can be determined; however, this implies that measurements without the development include effects due to a few structures not yet completed, such as those associated with the International Place development. Furthermore, there are some differences in the current proximity model compared to that previously used (Ref. 1) to reflect the most recent building projects in the area. The proximity model can be seen in Figure 6.2-5.

The entire model of the site and its immediate surroundings could be rotated to simulate any wind direction. The proximity model was preceded by the equivalent of about nine miles of approximately modelled terrain in order to develop a representative of the actual site topography. Three different terrain models were used. They are illustrated in Figure 6.2-8 and the azimuth ranges for which they were used area shown in Figure 6.2-9.

Figure 6.2-10 presents vertical profiles of the mean speed and the intensity of the longitudinal component of turbulence just upstream of the proximity model. The latter is a measure of the degree of gustiness in the wind relative to the average speed over 20 minutes to an hour. These velocities are further modified by the proximity model before reaching the site. The profiles shown are good representations of expected full scale wind speed variation with height, with the exception that the profile for exposure one is deeper than would be expected. This has the effect of reducing wind speeds over the height of the building. To compensate, a correction factor was included for this exposure only to effectively reduce the boundary layer depth to about 900 feet.

Representation of the Full-Scale Wind Climate

In order to make meaningful predictions of the wind environment around the site, it is convenient to derive a model of the expected mean wind speeds and directions at gradient height*, since this corresponds on one hand to the reference speed measured in the wind tunnel above the boundary layer, and on the other hand to full-scale speeds at a height which is representative of a broad geographic area and unaffected by local ground surface details. This has been previously

* A height where the flow first becomes essentially independent of ground roughness -- typically 1,000 to 2,500 feet.

accomplished for the Boston area (and is detailed in Reference 1). The most pertinent results of that study are presented here. The methodology of analysis of such wind data is described in general in Appendix B-2 and in Reference 1.

Briefly, the study of the wind climate produced two models, one based on upper level measurements, and the other based on surface measurements, converted to upper level, using correction dependent upon the upstream terrain for each wind direction. The two models have somewhat different wind directionalities associated with them and therefore, both models are used for making predictions, with the average prediction considered as the most appropriate value for use. The directionality of the two wind climate models for common events is shown in Figure 6.2-6a and the complete probability distributions of the two models are shown in Figure 6.2-6b. These two figures are complementary and show that for the return periods of interest for pedestrian comfort (once per week or once per month), the predominant wind directions are centered around the west. Furthermore, Figures 6.2-6a and 6.2-6b illustrate that the primary differences between the data sets occur for rarer events (the outer contours of Figure 6.2-6b). For common events (Figure 6.2-6a and the innermost contours of Figure 6.2-6b), the data sets are in reasonable agreement.

6.2.2.3 Experimental Procedure and Results

General

Pedestrian comfort depends largely on the magnitude of the ground level wind speed regardless of the local wind direction. As a result, quantitative evaluations of the pedestrian level wind environment at the Boundary Layer Wind Tunnel Laboratory are normally restricted to measurements of ground level wind speeds.

All wind speed measurements were made using linearized single-ended cylindrical hot-film sensors which are omni-directional and measure both the mean and the fluctuating components of the wind speed parallel to the ground at a height of about 6 to 8 feet full-scale. As seen in Figures 6.2-7a to 6.2-7c, locations were chosen from several viewpoints. Some are common to several configurations; some investigate the impact of the project on nearby pedestrian areas; some deliberately seek out possible windy sites near corners of buildings; and some represent typical locations in expected pedestrian routes and entrances servicing One Twenty Five High Street. The locations were chosen with the aid of the sand scour test, and therefore, should include the windiest areas around the site. Some locations are directly comparable to locations in Reference 4.

For each configuration examined, the experimental program comprised measurements of maximum, minimum, mean, and RMS (root-mean-square) wind speeds at the locations indicated in Figures 6.2-7a to 6.2-7c for a full range of wind direction varied in steps of 10° starting at true north. The sampling time in all cases (60 seconds in model scale) was chosen to provide stable estimates of the mean and RMS wind speeds and to correspond approximately to 1 hour in full scale. The measured pedestrian level wind speeds were subsequently expressed as speed coefficients or speed ratios by normalizing the measured data by the mean wind speed at gradient height. In this form they are equally applicable to model and full scale. All measurements were carried out using the automated computer-controlled data acquisition system available at the Laboratory. For all results presented in this report, mean wind speeds infer an average over a period of 20 minutes to an hour.

Experimental Results

Coefficients of mean and gust wind speeds for all configurations at the various measuring locations that were examined are displayed in Appendix B-3. Examples are also shown in Figure 6.2-11 to compare results for two typical locations, 4 and 18, which were tested for all three configurations. For each gradient wind direction, the plots of Figure 6.2-11 represent the fraction of the gradient wind speed expected at ground level. Each plot shows both the mean speed and an effective gust speed, defined as gust = mean + 1.5 RMS. This particular definition leads to a gust speed to which humans are expected to be sensitive. Further background for its definition can be found in Reference 5.

Comparisons of the coefficients measured in this study with those measured in the previous study (Ref. 1) for the current site configuration are shown in Appendix B-4. The agreement is very good. Some minor differences occur due to small differences in probe locations, proximity model alterations (to reflect recent construction), and model set-up.

Comparisons of coefficients between this study and the International Place study (Ref. 4) are shown in Appendix B-5. Peterka and Cermak's data were only taken at 22.5° intervals which does not provide as good resolution as developed here. Although there is general similarity in many cases, the detailed quantitative agreement is variable, as was also found previously in Reference 1. Most of the comparative locations available can be categorized into three classes: those in relatively open exposed areas to the south of the project (locations 1, 2, and 3), locations close to the International Place development (locations 6, 7, 8, 10, 11, and 12), and location in the more dense part of the city (locations 13, 15, 19, and 35). The locations close to the International Place show quite good agreement, considering that the exact locations of Peterka and Cermak's probes are not known (their report only provides a rough guide), and that there are some differences in the details

of the models tested (future projects, freeway ramp details, assumed upstream terrain roughness, etc.). Locations further within the city also show reasonable agreement, although not quite as good, probably for similar reasons, particularly since the locations are not clearly defined and the flows are not quite so dominated by a single building as is the case close to International Place. The locations 1, 2, and 3 show quite poor agreement. This is not fully understood. Although all of the details of Peterka and Cermark's tests are not available, it appears that some of the differences can be attributed to their use of a significantly more open terrain model for southwesterly wind directions. This is the quadrant that shows the worst agreement. The effects of this difference in upstream terrain modelling would show up most strongly in exposed southerly locations, since otherwise the built-up city would dominate, as in the first two categories. Since the directions for which the largest differences occur are not common wind directions, these discrepancies should have less effect on the statistical predictions of Section 6.2.2.4 below. This explanation, however, is not sufficient to explain the differences for location 2. It is difficult to see any aerodynamic reasons for such large results for the westerly wind directions; for other directions, the results are in reasonable agreement with the present study. Hence, the results for this location are considered to be anomalous.

The polar plots in Figure 6.2-11 and Appendix B-3 do not in themselves indicate the windiness of the plaza area in practice, since they do not include any effect of the statistics of the magnitudes and directions of the full-scale winds. Instead, they show only aerodynamic effects. Since prevailing winds are westerly, these directions are much more important in determining the wind conditions. This is discussed further in Section 6.2.2.4.

6.2.2.4 Statistical Predictions of Pedestrian Level Winds

General

Wind tunnel measurements of pedestrian level mean and gust wind speeds at the various locations for the three configurations were combined with the two probability distributions of gradient wind speed and direction to provide predictions of full-scale pedestrian level wind speeds. The average prediction from the two wind climate models is presented here. Such predictions essentially use the following technique: An arbitary speed of interest is set for a particular surface position (say 10 mph). By using the polar plots of Figure 6.2-11 and Appendix B-3, the gradient wind speed required to produce this surface speed can be calculated for each upper level wind direction. For each wind direction, the corresponding probability of this upper level wind speed occurring can be determined from the data of Figure 6.2-11. Integrating over all possible upper level wind directions provides the total probability of exceeding the original surface wind speed (10 mph). This can be repeated for any surface wind speed and, conversely, the surface wind speed corresponding to any probability level or recurrence period can be calculated. As a result, two types of predictions are available:

1) Predictions of mean and and peak or "gust" wind speeds exceeded during different percentages of the time at the various measuring locations.

2) Predictions of mean wind speeds exceeded during particular events or "storms" associated with various frequencies of occurrence, as presented in Section 6.2.5.3. Since a "storm" is associated with a

duration of several hours, these results cannot be directly deduced from the simple percentages of 1). Instead, they are determined from threshold crossing theory (Ref. 11).

Annual Wind Speeds Exceeded During 1% of the Time

Predictions of the mean and gust wind speeds exceeded 1% of the time on an annual basis are presented in Table 6.2-1 and Figures 6.2-12a and 6.2-12b. The gust speeds are shown in brackets. For reference, similar predictions are shown for typical suburban and open country environments. Suburban refers to one- and two-story residential areas, and open country refers to open fields with few trees. An urban comparison is not given because of the large variability that typically exists in urban environments.

In general, the windiest area around the site is along Oliver Street, but even there the wind speeds are between speeds expected in a typical suburban environment and those expected in an open country environment. Other areas around the site rarely exceed wind speeds typical of a suburban environment. Wind speeds near the entrances of the new development are particularly low.

Compared with the pre-build site, the effects of the 30-story building on the pedestrian level wind speeds can be seen to be as follows:

- o Oliver Street appears to be windier. The polar plots of Appendix B-3 show that, for easterly directions, the winds in this region are already quite strong due to the presence of the International Place. The addition of the 30-story building appears to cause a funneling and intensification of these easterly winds through Oliver Street. However, easterly winds are not very common.

- The added blockage caused by the 30-story building decreases the wind speeds at the easterly side of the International Place (locations 6 and 7).

- Winds on the walkway across the Central Artery and opposite the walkway on Purchase Street (locations 3 and 4) are decreased. The polar plots of Appendix B-3 show that the decrease occurs for easterly and southwesterly winds. This is likely a result of winds that could previously flow through the site now having to detour around the site and being slowed in doing so.

- These winds detouring around the site cause speeds to increase at the corner of Purchase Street and Pearl Street (locations 22 and 23).

- The pattern of changes in predicted wind speeds near the northern end of the site, as well as the polar plots of Appendix B-3, indicate that southwesterly winds flowing around the northern end of the building escape at the podium level, sheltering location 17. These winds return to ground level farther north, increasing speeds at location 14. Some of the winds flow around the building at ground level, increasing speeds at locations 15 and 18.

Compared to the pre-build site, the effects of the completed 30-story and 21-story buildings (full development) can be seen from the tables to be as follows:

- As with the addition of the 30-story building, winds in Oliver Street have increased somewhat, while winds at the easterly side of the International Place have decreased.

- o As with the addition of the 30-story building, southerly and westerly winds flowing around the 21-story building cause increased speeds at locations 18, 22, and 23. The podium shelters locations along High Street near Pearl Street (i.e., locations 17, 28, 29, and 31). The slightly increased speeds at location 14 probably are due to the influence of this second building.

Comparisons of 1% wind speeds from this study with those from the previous study and those from International Place study are shown in Table 6.2-2. Since the wind climate model used by Cermak for making predictions was based on a relatively short surface wind speed record, uncorrected for the effects of local terrain, it has not been used here. Instead, predictions have been made using Cermak's aerodynamic data with the wind climate models presented here (i.e., in exactly the same manner as the predictions in this report).

Comparisons between this study and the previous study are very good. This high level of repeatability lends confidence to the results. Comparisons with Cermak's data follow the trends previously commented on in Section 6.2.2.3. The common locations near International Place (6 to 12) and the common locations within the city (13 to 35) show good agreement on average; however, the three exposed locations around and across the Central Artery (1, 2, and 3) are all in very poor agreement, especially the anomalous location 2.

Seasonal Variations

Seasonal variations of mean and gust speeds were calculated based on the wind frequency distributions derived from the Boston surface data (wind climate model I). The seasonal information from the upper level data were not considered as reliable due to the shorter record length available.

Table 6.2-3 presents the wind speeds exceeded 1% of the time during various calendar seasons (January - March, April - June, etc.) as ratios of the wind speed exceeded 1% of the time annually. The results indicate only small seasonal variations in wind speed. Wind speeds in autumn and winter are close to the annual wind speeds. Wind speeds in spring are 5% to 10% greater than the annual speeds, while in summer they are 10% to 15% less.

Prediction of Events or "Storms" for Different Frequencies of Occurrence

The annual frequency of occurrence of events or "storms" during which particular values of pedestrian level mean wind speed are exceeded was estimated using procedures described in References 6 and 11. A summary of the mean wind speeds exceeded during events with different average rates of occurrence for all locations is presented in Figure 6.2-13 for the three configurations examined. The duration of such "storms" or events can also be estimated and is typically in the range of two to five hours.

Also shown in Figure 6.2-13 are curves of acceptance criteria for pedestrian level wind conditions as initially proposed by Davenport (3). The rationale for these criteria, which are based on the Beaufort scale, are discussed in detail elsewhere (Refs. 6 and 12). They are also given in tablular form in Table 6.2-4 as excerpted from Reference 13. These criteria allow for the increase in sensitivity of pedestrians to wind speeds occurring with high frequencies of occurrence and the reduction of the comfort and/or tolerance level of people engaged in sedentary and generally more leisurely activities. The curve for each indicated activity level gives the mean wind speed at a particular annual frequency of occurrence above which conditons may become objectionable to individuals engaged in that activity. The criteria presented in Figure 6.2-13 and Table 6.2-4 do not allow for differences in air temperature,

solar radiation, clothing, sex, age, physical fitness, and the acclimatization of individuals exposed to particular wind environments. While acceptable criteria at relatively high frequencies of occurrence are largely based on considerations of comfort, relatively infrequent events are based on considerations of safety. All criteria curves merge at a mean wind speed of about 34 mph, regarded as the onset of physical danger in the form of a loss of balance or the toppling of an infirm or elderly person by a strong gust. The occurrence of such wind speeds more than once per annum is considered to be undesirable regardless of activity.

The results of Figure 6.2-13 generally confirm those trends seen in the 1% speed results. The development decreases wind speeds at some locations and increases it at others. At most locations which were monitored for both pre-build and full development, little net effect is observed. Only locations 9 and 23 show significant increases. The latter location is at the corner of Pearl and Purchase Streets where the increased windiness is directly attributable to the new development; however, it is well within acceptable limits for the likely pedestrian activities in this area. Location 9 is on Oliver Street between One Twenty Five High Street and the International Place where the windiest locations in the development are found. One Twenty Five High Street does not exacerbate the wind speed at location 8, but does increase speeds in the middle of the street at location 9, which is located at the center of the local windy area as indicated by the sand scouring tests. This area is relatively sheltered for the most common winds (see polar plots, Appendix B-3); however, strong surface winds are induced by the presence of the International Place for easterly winds and, even though easterly winds are less common, they still lead to significant winds a few times a year. It is significant that the predicted 1% speeds for locations 7 and 8, both before development and after development are very similar to those determined by Peterka and Cermak, indicating that the International Place is the prime cause of this windy region.

Amelioration of conditions in this region are difficult, since they are associated with winds accelerating arouna the southernmost International Place Tower. One possibility might be to introduce some form of wind barrier, such as trees, on the northeast corner of Purchase and Oliver Streets directly south of the International Place Tower.

Figure 6.2-14 presents a simplification of the data presented in Figure 6.2-13 in order to illustrate the windiness for particular areas. Each location/configuration combination has been classified as appropriate to the activities numbered 1 to 4 in Table 6.2-4 on the basis of predictions of wind speed expected on average once per month as gased on the annual wind climate. Note that a larger activity number denotes suitability for a more leisurely activity. The choice of a monthly rate of occurrence is an arbitrary one; however, as indicated by the summary plots of Figure 6.2-14, this choice is not likely to change the comparative results. This is due to the fact that both the predicted speeds and the tolerable wind speeds for particular activities reduce at about the same rate. For reference, the classification of typical suburban and open country environments is also shown in Figure 6.2-14 on the same basis. It is apparent that the speeds for the locations examined around the site are consistent with a typical suburban environment except along Oliver Street and at the corner of Purchase and Pearl Streets. The trends noted above are again apparent.

6.2.3 Stage III - Supplemental Quantitative Study

6.2.3.1 Introduction

This section presents the results of supplementary study to the studies previously described.

The aim of the current study was to evaluate the effects of two geometry changes:

1) The geometry of the 21-story building and that of some of the low-rise has changed.

2) The top 25 stories of the 30-story building have been shifted approximately 17 feet to the north.

As well, several new locations were examined to better understand the wind conditions along Oliver Street. In particular, some relatively windy locations were previously monitored; however, they were actually in the roadway. The new locations are nearby but on the sidewalk.

Thirty-two locations were examined for two site configurations: the 30-story building alone and the 30-story building with the 21-story building. In addition, 16 locations, including the new locations, were examined with the site as it currently exists. The locations examined are shown in Figures 6.2-15 to 6.2-17 for the three site configurations.

6.2.3.2 Experimental Results

Coefficients of mean and gust wind speeds for all configurations at the various measuring locations that were examined are displayed in Appendix B-6. For each gradient wind direction, the plots of Appendix B-6 represent the fraction of the gradient wind speed expected at ground level. Each plot shows both the mean speed and an effective gust speed, defined as gust = mean + 1.5 RMS. This particular definition leads to a gust speed to which humans are expected to be sensitive.

Some of the positions examined correspond exactly or very nearly so to those of previous experiments. On the whole, these data were found to repeat very well. Some show slight changes, of the order of 5% to 10%, which must be attributed to accumulated experimental errors. However, the data for location 13 with only the 30-story tower present, shows significantly lower wind speeds than were seen there for this configuration in the previous test. The new data, however, is much more

consistent with the data for other configurations than the previous data was. Furthermore, it was previously difficult to rationalize why this particular configuration led to such high wind speeds at this location. It is concluded, then, that the previous data for location 13 with the 30-story building only configuration was incorrect for some unknown reason, and has been deleted from the previous report.

The polar plots in Appendix B-6 do not in themselves indicate the windiness of the plaza in practice, since they do not include any effects of the statistics of the magnitudes and directions of the full-scale winds. Instead, they show only aerodynamic effects. Since prevailing winds are westerly, these directions are much more important in determining the wind conditions. This is discussed further below.

6.2.3.3 Statistical Predictions of Pedestrian Level Winds - General

Wind tunnel measurements of pedestrian level mean and gust wind speeds at the various locations for the three configurations was combined with the two probability distributions of gradient wind speed and direction (as described in Section 6.2.2) to provide predictions of full-scale pedestrian level wind speeds. The average prediction from the two wind climate models is presented here. Two types of predictions are available:

1) Predictions of mean and peak or "gust" wind speeds exceeded during different percentages of the time at the various measuring locations.

2) Predictions of mean wind speeds exceeded during particular events or "storms" associated with various frequencies of occurrence.

6.2.3.4 Wind Speeds Exceeded During 1% of the Time

Annual Results

Predictions of the mean and gust wind speeds exceeded 1% of the time on an annual basis are presented in Table 6.2-5 and Figures 6.2-18 and 6.2-19. For reference, similar predictions are shown for typical suburban and open country environments. Suburban refers to one- and two-story residential areas, and open country refers to open fields with few trees. An urban comparison is not given because of the large variability that typically exists in urban environments.

The following observations can be made from Figure 6.2-18 and 6.1-19:

- o Peak speeds to not exceed 30 mph at any of the locations examined.

- o The effects of the geometry changes are generally to decrease wind speeds.

- o The new locations in Oliver Street, which were placed on the sidewalk, show lower speeds than at previous locations such as 8 and 9, which were placed on the road.

- o The previous data for location 13 with only the 30-story building present appears to be in error. The current data is much more consistent with other data for this location and is also lower than the previous data. This location is no longer a problem.

Table 6.2-6 shows the number of locations falling into Melbourne's acceptability criteria categories for the three configurations. Note that the before development column includes some data from Section 6.2.2. The table shows that no locations fall into the unacceptable category and only one quarter (mostly in Oliver Street) fall into the uncomfortable for walking category. The presence of the One Twenty Five High Street development has only a minor effect: few more locations are in the uncomfortable category and a few more are in the lowest speed category.

In order to evaluate the effects of precisely modelling the upstream roughness, the tests were redone with a somewhat smoother exposure to the south and east. The effects on the 1% speeds were less than a 10% variation and tended to be upwards as would be expected. This indicates that although the roughness placed upstream should be generally accurate, it need not be precisely accurate.

Seasonal Results

Seasonal variations of mean and gust speeds were calculated based on the wind frequency distributions derived from the Boston surface data (wind climate model I - see Section 6.2.2). The seasonal information from the upper level data were not considered as reliable due to the shorter record length available.

Table 6.2-7 presents the wind speeds exceeded 1% of the time during various calendar seasons (December-February, March-May, etc.) as ratios of the wind speed exceeded 1% of the time annually. The results indicate only small seasonal variations in wind speeds. Wind speeds in the autumn and winter are generally close to the annual wind speeds. Wind speeds in spring are generally 5% to 10% greater than the annual speeds, while in summer they are generally 10% to 15% less. Note that these are general trends and trends at particular locations may

differ. This dependence on location is due to the differences in important wind directions for different locations, in combination with the fact that the seasons have different wind directionalities.

6.2.3.5 Prediction of Events or "Storms" for Different Frequencies of Occurrence

A summary of the mean wind speeds exceeded during events with different average rates of occurrence for all locations is presented in Figure 6.2-20 for the three configurations examined. The duration of such "storms" or events can also be estimated and is typically in the range of two to five hours.

Also shown in Figure 6.2-20 are curves of acceptance for pedestrian level wind conditions as initially proposed by Davenport. These criteria allow for the increase in sensitivity of pedestrians to wind speeds occurring with high frequencies of occurrence and the reduction of the comfort and/or tolerance level of people engaged in sedentary and generally more leisurely activities. The curve for each indicated activity level gives the mean wind speed at a particular annual frequency of occurrence above which conditions may become objectionable to individuals engaged in that activity. The criteria presented in Figure 6.2-20 do not allow for differences in air temperature, solar radiation, clothing, sex, age, physical fitness, and the acclimatization of individuals exposed to particular wind environments. While acceptable criteria at relatively high frequencies of occurrence are largely based on considerations of comfort, relatively infrequent events are based on considerations of safety. All criteria curves merge at a mean wind speed of about 34 mph, regarded as the onset of physical danger in the form of a loss of balance or the toppling of an infirm or elderly person by a strong gust. The occurrence of such wind speeds more than once per annum is considered to be undesirable regardless of activity.

The results of Figure 6.2-20 generally confirm those trends seen in the 1% speed results and in Section 6.2.2. The geometry changes tend to decrease speeds. The windy locations in Oliver Street were windy before development while the development decreases speeds at some locations. Locations on the sidewalk are not as windy as those in the street. Most locations around the site have wind speeds that would be acceptable for activities such as strolling. Many would be comfortable for even more leisurely activities.

Probe	Current Site	30-Story Building	30-Story and 21-Story Buildings	Ratios of Results: 30-Story Building / Current Site	Ratios of Results: 30-Story and 21-Story Buildings / Current Site	Ratios of Results: 30-Story and 21-Story Buildings / 30-Story Building
1	14.5 (22.4)	14.5 (22.1)	14.3 (21.7)	1.00 (0.99)	0.99 (0.97)	0.99 (0.98)
2	17.6 (22.7)	16.5 (21.5)	15.1 (19.8)	0.94 (0.95)	0.86 (0.87)	0.92 (0.92)
3	15.4 (21.0)	13.7 (18.3)	17.3 (22.9)	0.89 (0.87)	1.12 (1.09)	1.26 (1.25)
4	14.8 (20.4)	10.5 (16.5)	10.1 (16.2)	0.71 (0.81)	0.68 (0.79)	0.96 (0.98)
5	17.1 (23.3)	18.1 (24.8)	18.3 (24.7)	1.06 (1.06)	1.07 (1.06)	1.01 (0.99)
6	15.3 (21.8)	13.8 (19.3)	13.6 (19.3)	0.90 (0.89)	0.89 (0.89)	0.99 (1.00)
7	21.5 (26.6)	18.4 (23.1)	19.1 (24.2)	0.86 (0.87)	0.89 (0.91)	1.04 (1.05)
8	23.5 (28.2)	27.2 (31.9)	24.4 (29.8)	1.16 (1.13)	1.04 (1.06)	0.89 (0.93)
9	20.4 (24.6)	24.3 (29.6)	28.5 (34.3)	1.19 (1.20)	1.40 (1.39)	1.17 (1.16)
10	17.7 (23.6)	18.3 (24.9)	20.1 (25.3)	1.03 (1.06)	1.14 (1.07)	1.10 (1.02)
11	18.7 (25.4)	17.7 (24.1)	16.3 (22.4)	0.95 (0.95)	0.87 (0.88)	0.92 (0.93)
12	21.7 (27.7)	20.9 (26.7)	20.3 (25.8)	0.96 (0.96)	0.94 (0.93)	0.97 (0.97)
13	17.9 (25.8)		19.2 (27.5)		1.07 (1.07)	
14	11.0 (17.3)	12.6 (18.6)	13.3 (19.5)	1.15 (1.08)	1.20 (1.13)	1.10 (1.05)
15	12.9 (20.3)	16.5 (22.3)	11.9 (18.9)	1.28 (1.10)	0.92 (0.93)	0.72 (0.85)
16	12.6 (17.8)	12.5 (18.1)	11.2 (16.8)	0.99 (1.02)	0.89 (0.94)	0.90 (0.93)
17	13.9 (21.8)	13.0 (19.3)	12.4 (18.6)	0.94 (0.89)	0.89 (0.85)	0.95 (0.96)
18	12.8 (18.7)	16.2 (22.1)	15.4 (21.0)	1.27 (1.18)	1.20 (1.12)	0.95 (0.95)
19	11.0 (16.5)	10.7 (16.4)	11.8 (17.4)	0.97 (0.99)	1.07 (1.05)	1.10 (1.06)
20	15.2 (22.3)	15.3 (21.7)	15.5 (22.2)	1.01 (0.97)	1.02 (0.99)	1.01 (1.02)
21	11.6 (16.9)	10.1 (15.7)	10.2 (16.1)	0.87 (0.93)	0.88 (0.95)	1.00 (1.03)
22	8.5 (13.1)	11.6 (17.8)	12.4 (18.6)	1.36 (1.36)	1.46 (1.42)	1.07 (1.04)
23	13.1 (19.6)	18.4 (23.0)	18.9 (23.1)	1.40 (1.17)	1.44 (1.18)	1.03 (1.00)
24		19.2 (23.8)	20.2 (24.7)			1.05 (1.04)
25		13.4 (19.1)	14.1 (20.2)			1.05 (1.06)
26		13.1 (18.0)	12.3 (17.1)			0.94 (0.95)
27		6.6 (10.6)	5.5 (8.3)			0.83 (0.78)
28		15.1 (20.7)	11.3 (17.6)			0.75 (0.85)
29		11.5 (17.5)	12.2 (17.8)			1.06 (1.02)
30		15.3 (23.0)	16.8 (23.7)			1.10 (1.03)
31			8.6 (13.9)			
32	13.0 (20.5)	10.2 (16.1)		0.78 (0.79)		
33	12.4 (18.4)					
34	17.8 (23.7)					
35	11.4 (17.9)					

Legend	Mean (Gust)
Typical Open Country	26.6 (34.6)
Typical Suburban	17.0 (30.7)

Probe 13: information deleted (See page 6.2-26)

*Note: Differences of less than 10% are not considered significant

TABLE 6.2-2

WIND SPEEDS (MPH) EXCEEDED 1% OF THE TIME ON AN ANNUAL BASIS

PRESENT SITE CONFIGURATION

Probe	Current Study	Previous Study	Peterka & Cermak's Data*
1	14.5 (22.4)		23.0 (32.6)
2	17.6 (22.7)		43.3 (59.7)
3	15.4 (21.0)		23.1 (35.0)
4	14.8 (20.4)	15.2 (20.8)	12.9 (20.1)
5	17.1 (23.3)	18.5 (26.7)	
6	15.3 (21.8)		22.7 (32.8)
7	21.5 (26.6)		22.5 (30.3)
8	23.5 (28.2)		18.7 (24.7)
9	20.4 (24.6)	22.4 (29.0)	
10	17.7 (23.6)	21.2 (27.9)	16.6 (23.7)
11	18.7 (25.4)		22.7 (31.0)
12	21.7 (27.7)	20.0 (26.0)	18.9 (25.9)
13	17.9 (25.8)	18.1 (25.5)	16.7 (24.1)
15	12.9 (20.3)		16.5 (23.6)
19	11.0 (16.5)		18.3 (27.0)
20	15.2 (22.3)	12.1 (18.9)	
23	13.1 (19.6)	12.7 (18.4)	
35	11.4 (17.9)		13.9 (21.3)

* These predictions are not taken directly from Peterka and Cermak's report. Instead, they were derived using their aerodynamic data and the climate models presented in this report.

WIND SPEEDS EXCEEDED 1% OF THE TIME DURING VARIOUS SEASONS AS RATIOS OF THE SPEED EXCEEDED 1% OF THE TIME ANNUALLY

WIND SPEEDS EXCEEDED 1% OF THE TIME DURING VARIOUS SEASONS AS RATIOS OF THE SPEED EXCEEDED 1% OF THE TIME ANNUALLY

	PRESENT SITE				30-STORY BUILDING				FULL DEVELOPMENT			
Probe	**Spring**	**Summer**	**Autumn**	**Winter**	**Spring**	**Summer**	**Autumn**	**Winter**	**Spring**	**Summer**	**Autumn**	**Winter**
1	1.05 (1.02)	0.76 (0.79)	1.00 (0.98)	1.06 (1.05)	1.05 (1.02)	0.76 (0.80)	1.00 (0.98)	1.06 (1.05)	1.05 (1.02)	0.76 (0.80)	1.00 (0.98)	1.06 (1.05)
2	1.10 (1.09)	0.75 (0.75)	0.99 (0.99)	0.98 (0.99)	1.10 (1.09)	0.75 (0.75)	0.99 (0.99)	0.98 (0.99)	1.10 (1.09)	0.76 (0.75)	0.99 (0.99)	0.98 (0.99)
3	1.09 (1.07)	0.73 (0.75)	1.00 (0.99)	1.00 (1.01)	1.09 (1.07)	0.73 (0.75)	1.01 (1.00)	1.00 (1.01)	1.09 (1.07)	0.73 (0.76)	1.01 (0.99)	1.00 (1.01)
4	1.09 (1.08)	0.79 (0.76)	0.99 (0.99)	0.99 (1.00)	1.02 (1.01)	0.80 (0.82)	0.98 (0.98)	1.02 (1.03)	1.02 (1.01)	0.80 (0.82)	0.99 (0.98)	1.02 (1.02)
5	1.09 (1.09)	0.75 (0.76)	0.99 (0.99)	0.99 (0.99)	1.10 (1.09)	0.74 (0.74)	1.00 (0.99)	0.99 (1.00)	1.09 (1.09)	0.73 (0.74)	1.00 (1.00)	1.00 (1.00)
6	1.07 (1.04)	0.76 (0.78)	0.99 (0.99)	1.01 (1.02)	1.08 (1.06)	0.74 (0.75)	1.00 (0.99)	1.01 (1.02)	1.08 (1.06)	0.74 (0.76)	1.00 (0.99)	1.01 (1.02)
7	1.09 (1.09)	0.75 (0.74)	0.99 (0.99)	0.99 (0.99)	1.09 (1.09)	0.75 (0.75)	0.99 (0.99)	0.99 (0.99)	1.10 (1.09)	0.75 (0.75)	0.99 (0.99)	0.98 (0.99)
8	1.08 (1.08)	0.76 (0.75)	0.98 (0.99)	0.99 (0.99)	1.08 (1.08)	0.77 (0.76)	0.98 (0.98)	0.99 (0.99)	1.09 (1.08)	0.76 (0.75)	0.98 (0.99)	0.99 (1.00)
9	1.08 (1.08)	0.76 (0.75)	0.99 (0.99)	0.99 (0.99)	1.08 (1.08)	0.76 (0.75)	0.98 (0.99)	0.99 (0.99)	1.09 (1.08)	0.75 (0.74)	0.99 (0.99)	0.99 (0.99)
10	1.08 (1.07)	0.77 (0.76)	0.97 (0.98)	0.99 (1.00)	1.08 (1.08)	0.76 (0.75)	0.99 (0.99)	0.99 (1.00)	1.08 (1.08)	0.77 (0.76)	0.97 (0.98)	0.98 (1.00)
11	1.04 (1.03)	0.75 (0.76)	1.00 (0.99)	1.06 (1.06)	1.05 (1.04)	0.74 (0.75)	1.00 (1.00)	1.06 (1.06)	1.06 (1.05)	0.73 (0.74)	1.00 (1.00)	1.05 (1.06)
12	1.10 (1.08)	0.83 (0.80)	0.96 (0.97)	0.98 (1.00)	1.10 (1.09)	0.83 (0.81)	0.96 (0.97)	0.98 (0.99)	1.10 (1.09)	0.83 (0.81)	0.96 (0.97)	0.97 (0.98)
13	1.03 (1.03)	0.77 (0.77)	0.95 (0.94)	1.06 (1.07)					1.04 (1.03)	0.76 (0.76)	0.94 (0.94)	1.07 (1.08)
14	1.07 (10.5)	0.77 (0.78)	0.98 (0.97)	1.00 (1.01)	1.08 (1.06)	0.80 (0.79)	0.98 (0.98)	0.99 (1.00)	1.07 (1.06)	0.76 (0.76)	1.00 (0.99)	1.03 (1.03)
15	1.05 (1.03)	0.80 (0.78)	0.95 (0.94)	1.03 (1.06)	1.11 (1.09)	0.84 (0.82)	0.94 (0.95)	0.95 (0.99)	1.06 (1.04)	0.78 (0.77)	0.95 (0.94)	1.04 (1.06)
16	1.05 (1.03)	0.81 (0.78)	0.97 (0.97)	1.02 (1.04)	1.07 (1.05)	0.81 (0.78)	0.97 (0.98)	1.00 (1.02)	1.05 (1.04)	0.77 (0.76)	0.99 (0.99)	1.02 (1.04)
17	1.03 (1.02)	0.77 (0.77)	0.95 (0.95)	1.07 (1.06)	1.08 (1.05)	0.80 (0.79)	0.97 (0.97)	0.99 (1.01)	1.04 (1.02)	0.77 (0.80)	1.00 (0.99)	1.04 (1.03)
18	1.06 (1.03)	0.82 (0.81)	0.97 (0.97)	1.01 (1.02)	1.05 (1.05)	0.79 (0.79)	0.97 (0.97)	1.01 (1.01)	1.02 (1.02)	0.82 (0.82)	0.97 (0.97)	1.02 (1.02)
19	1.08 (1.04)	0.84 (0.83)	0.96 (0.97)	0.97 (1.00)	1.05 (1.03)	0.84 (0.83)	0.97 (0.97)	0.99 (1.00)	1.09 (1.06)	0.85 (0.84)	0.95 (0.96)	0.97 (0.99)
20	1.03 (1.03)	0.75 (0.77)	0.96 (0.95)	1.06 (1.05)	1.03 (1.03)	0.75 (0.76)	0.97 (0.96)	1.05 (1.05)	1.03 (1.03)	0.76 (0.77)	0.97 (0.96)	1.05 (1.05)
21	1.09 (1.09)	0.82 (0.81)	0.96 (0.96)	0.97 (0.98)	1.03 (1.03)	0.80 (0.80)	0.98 (0.97)	1.02 (1.03)	1.03 (1.04)	0.81 (0.80)	0.97 (0.97)	1.02 (1.02)
22	1.11 (1.08)	0.75 (0.76)	1.00 (1.00)	0.98 (1.00)	1.07 (1.03)	0.78 (0.81)	0.99 (0.98)	1.00 (1.02)	1.08 (1.05)	0.75 (0.78)	1.00 (0.98)	0.99 (1.01)
23	1.08 (1.06)	0.76 (0.76)	0.99 (0.99)	1.00 (1.01)	1.08 (1.08)	0.78 (0.77)	0.98 (0.98)	0.99 (0.99)	1.08 (1.08)	0.79 (0.78)	0.97 (0.98)	0.98 (0.99)
24					1.10 (1.09)	0.82 (0.81)	0.95 (0.96)	0.96 (0.97)	1.10 (1.09)	0.83 (0.81)	0.95 (0.95)	0.96 (0.96)
25					1.03 (1.03)	0.77 (0.78)	0.99 (0.99)	1.04 (1.03)	1.05 (1.04)	0.78 (0.79)	0.99 (0.98)	1.03 (1.02)
26					1.03 (1.02)	0.78 (0.80)	0.98 (0.98)	1.03 (1.02)	1.01 (1.00)	0.82 (0.83)	0.98 (0.97)	1.03 (1.03)
27					1.06 (1.04)	0.79 (0.78)	0.98 (0.97)	1.01 (1.03)	1.03 (1.02)	0.77 (0.78)	0.96 (0.96)	1.05 (1.05)
28					1.12 (1.10)	0.81 (0.80)	0.96 (0.97)	0.96 (0.98)	1.06 (1.05)	0.75 (0.78)	0.99 (0.98)	1.03 (1.02)
29					1.08 (1.06)	0.81 (0.80)	0.96 (0.97)	0.98 (1.00)	1.05 (1.03)	0.75 (0.78)	1.00 (0.99)	1.06 (1.05)
30					1.04 (1.04)	0.76 (0.75)	0.99 (0.99)	1.03 (1.03)	1.06 (1.05)	0.77 (0.76)	0.97 (0.96)	1.01 (1.03)
31									1.06 (1.04)	0.77 (0.77)	0.98 (0.97)	1.05 (1.06)
32	1.06 (1.05)	0.83 (0.82)	0.97 (0.97)	0.99 (1.00)	1.07 (1.07)	0.80 (0.80)	0.97 (0.97)	1.00 (1.00)				
33	1.08 (1.05)	0.80 (0.79)	0.97 (0.98)	0.98 (1.00)								
34	1.11 (1.10)	0.74 (0.74)	0.99 (0.99)	0.98 (0.98)								
35	1.05 (1.04)	0.75 (0.76)	0.98 (0.98)	1.05 (1.05)								
Average	**1.07 (1.06)**	**0.78 (0.77)**	**0.98 (0.98)**	**1.01 (1.02)**	**1.07 (1.06)**	**0.78 (0.78)**	**0.98 (0.98)**	**1.00 (1.01)**	**1.06 (1.05)**	**0.77 (0.78)**	**0.98 (0.98)**	**1.01 (1.02)**

Legend Mean (Gust)

Probe 13: information deleted

TABLE 6.2-4

COMFORT CRITERIA FOR WINDINESS

Units: Beaufort Number Temperature > 10^{o}C

Activity	Areas Applicable	RELATIVE COMFORT			
		Perceptible	Tolerable	Unpleasant	Dangerous
1. Walking fast	Sidewalks	5	6	7	8
2. Strolling, skating	Parks, entrances skating rinks	4	5	6	8
3. Standing, sitting – short exposure	Parks, plaza areas	3	4	5	8
4. Standing, sitting – long exposure	Outdoor restaurants, bandshells, theatres	2	3	4	8
Represenative criteria for acceptability			< 1 occn./week	< 1 occn./month	< 1 occn./yr.

At lower temperatures, relative comfort level might be expected to be reduced by one Beaufort number for every 20^{o}C reduction in temperature.

EXTRACTS FROM BEAUFORT SCALE

Force	Description	Wind Speeds* (miles/hour) Mean	Limits	Specifications
2	Light breeze Gentle breeze	5 (4)	4–7 (3–6)	*Wind felt on faces;* leaves rustle
3	Gentle breeze	10 (8)	8–12 (6–10)	Leaves and small twigs in constant motion; wind extends light flag
4	Moderate breeze	15 (12)	12–18 (10–15)	*Raises dust and loose paper;* small branches are moved
5	Fresh breeze	21 (17)	19–24 (15–20)	Small trees in leaf begin to sway
6	Strong breeze	28 (22)	25–31 (19–25)	Large branches in motion; whistling heard in telephone wires; *umbrellas used with difficulty*
7	Moderate gale	35 (28)	32–39 (25–31)	Whole trees in motion; *inconvenience felt when walking against wind*
8	Gale	42 (34)	39–46 (31–38)	Breaks twigs off trees; *generally impedes progress*

* Wind speed at reference height of 30 ft; nearer the ground, at 6 ft. say, the speeds may be about 80% of the mean speeds indicated (figures shown in brackets).

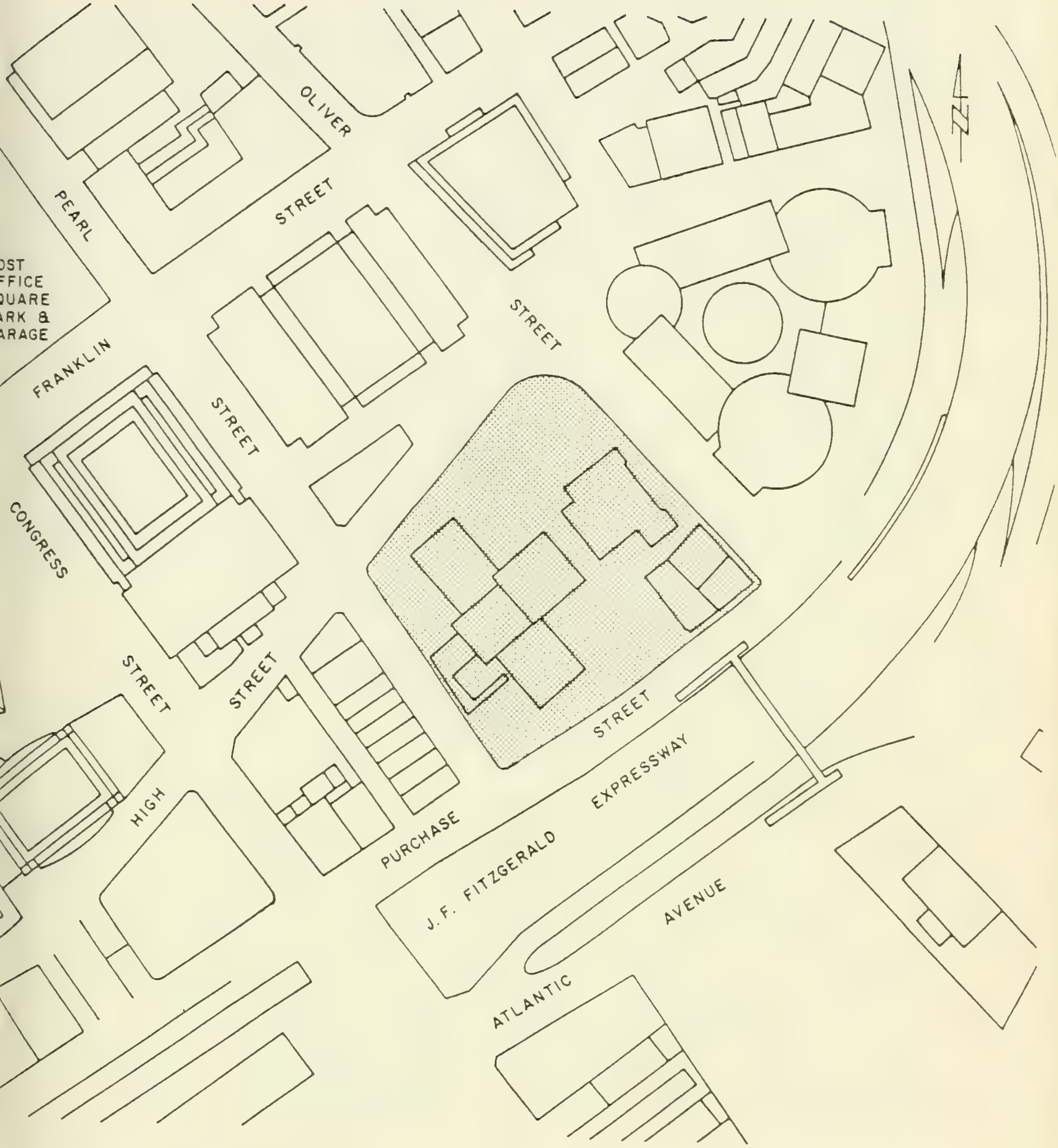


FIGURE 6.2-1 DIAGRAM SHOWING THE PRESENT SITE CONFIGURATION

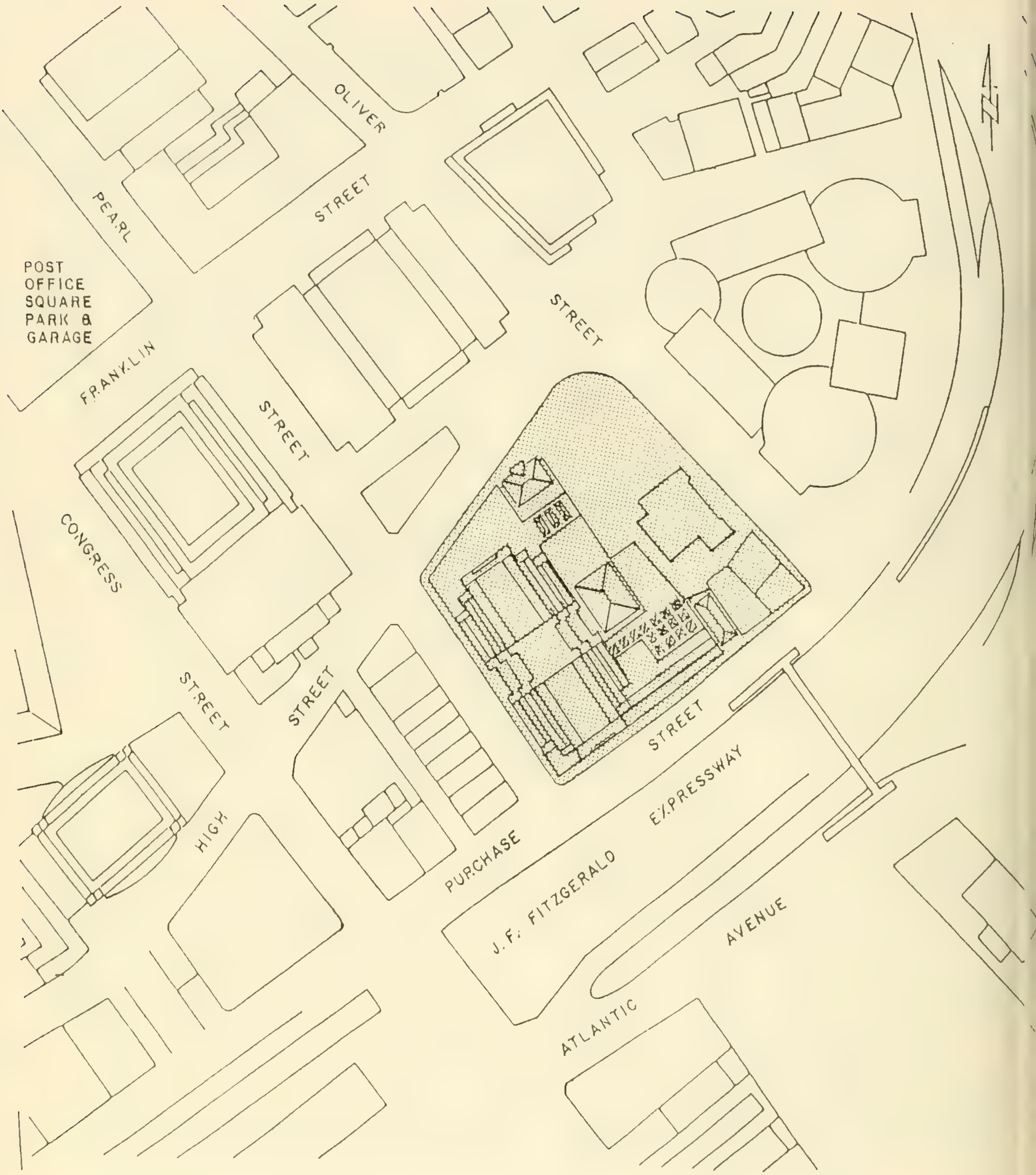


FIGURE 6.2-2 DIAGRAM SHOWING THE 30-STORY BUILDING

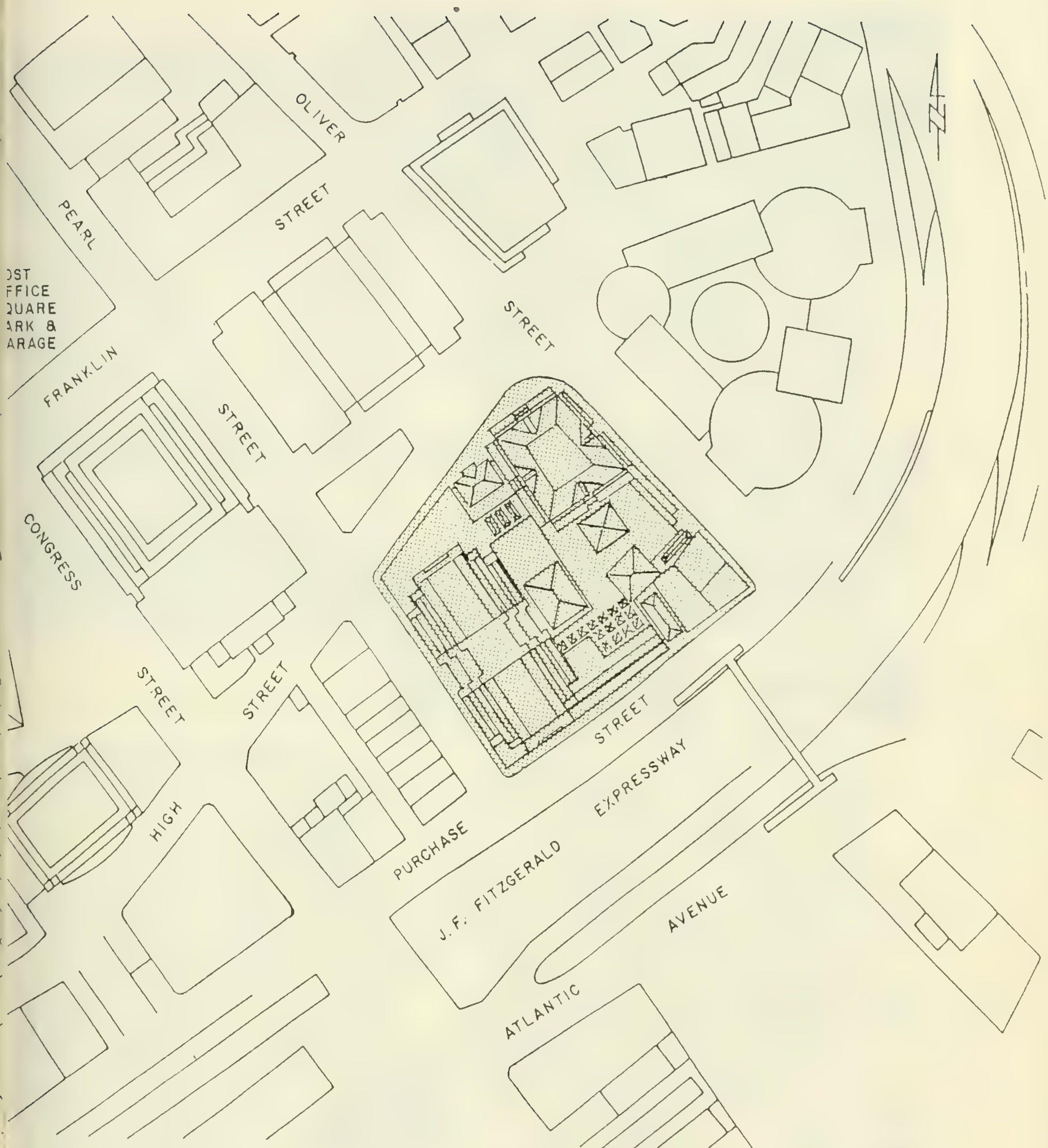
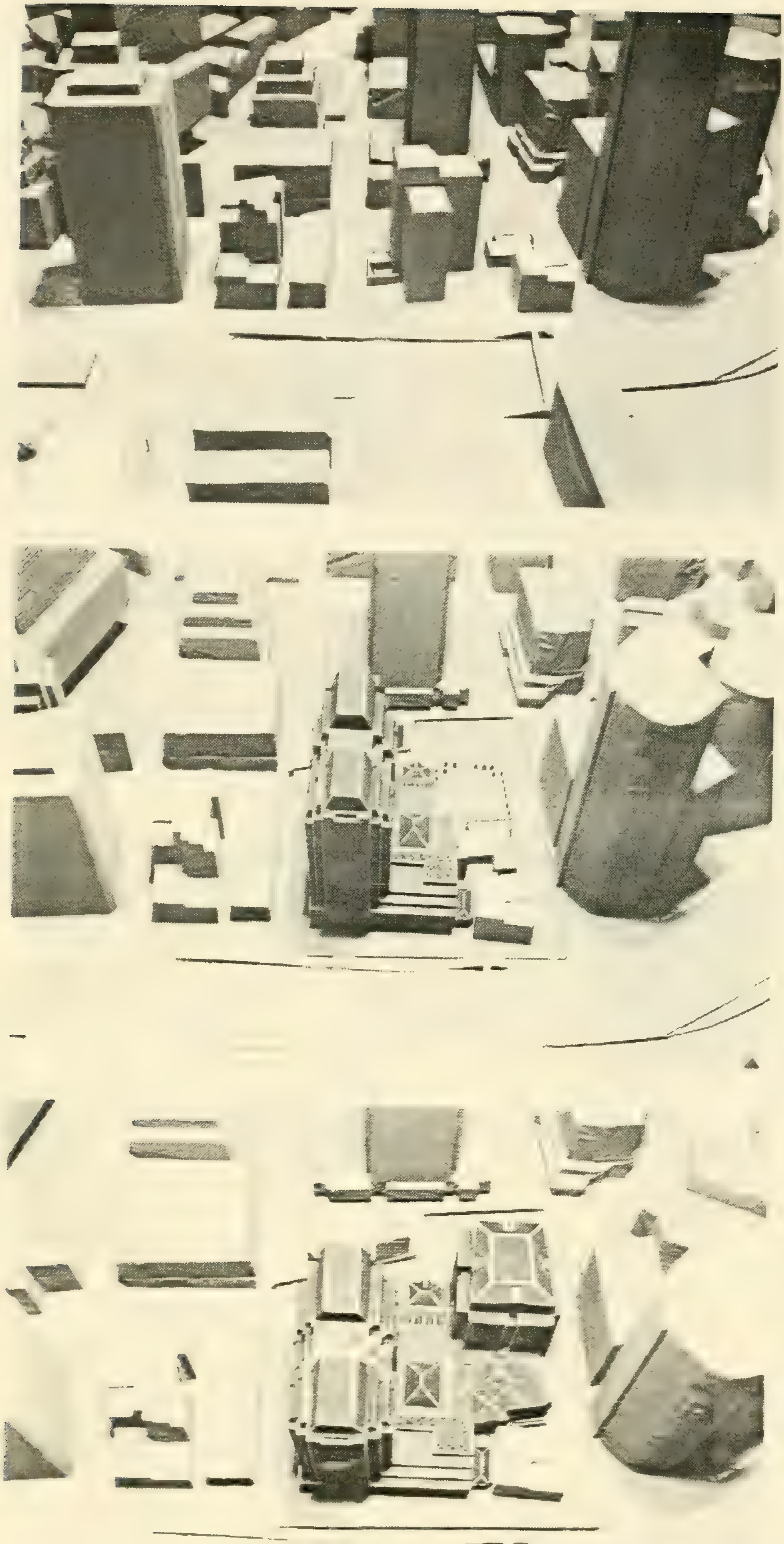


FIGURE 6.2-3 DIAGRAM SHOWING THE 30-STORY BUILDING AND THE 21-STORY BUILDING



PRESENT SITE

THE 30-STORY BUILDING

30-STORY BUILDING AND THE 21-STORY BUILDING

FIGURE 6.2-4 PHOTOS OF THE THREE CONFIGURATIONS

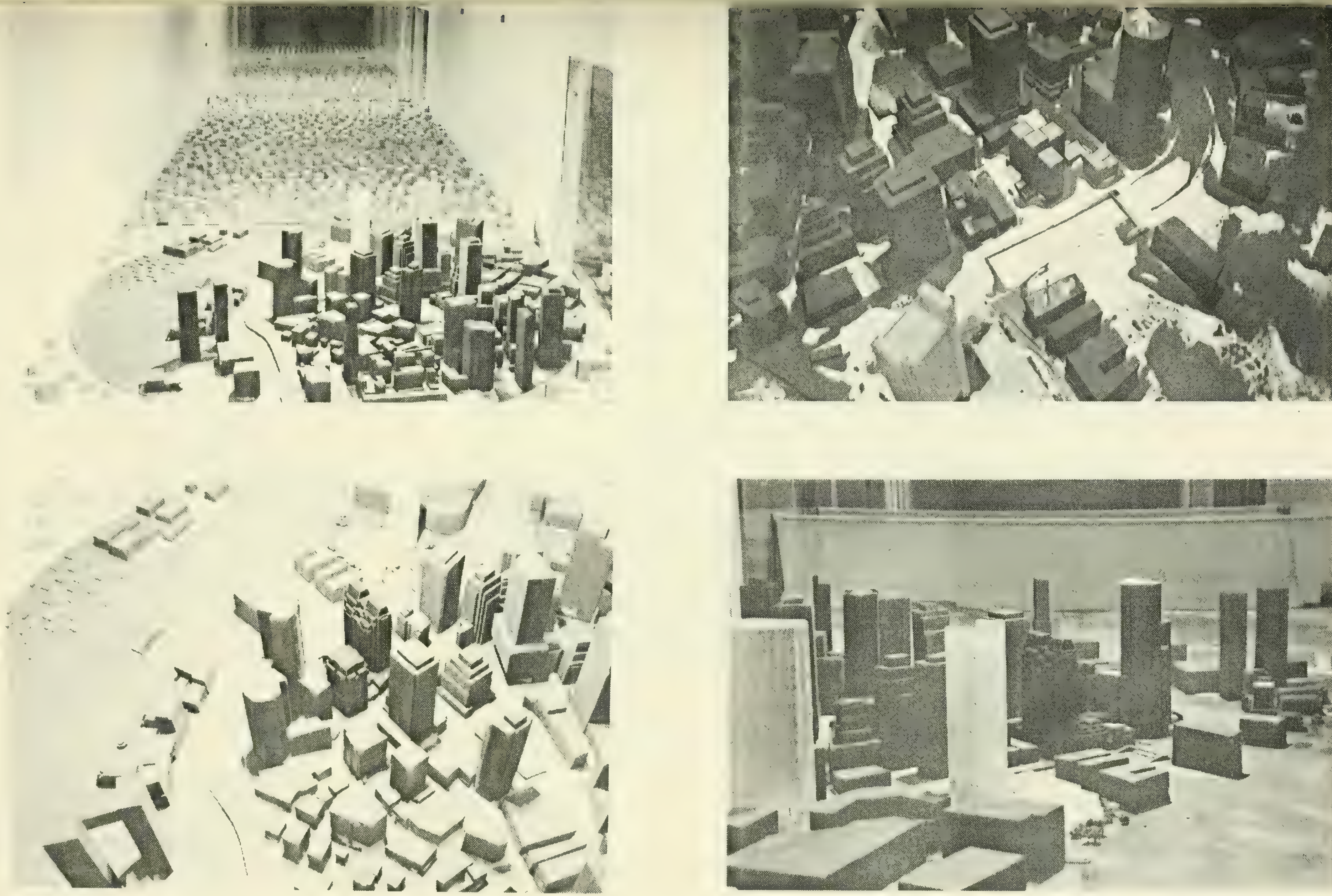


FIGURE 6.2-5 PHOTOS SHOWING THE EXPERIMENTAL SET-UP

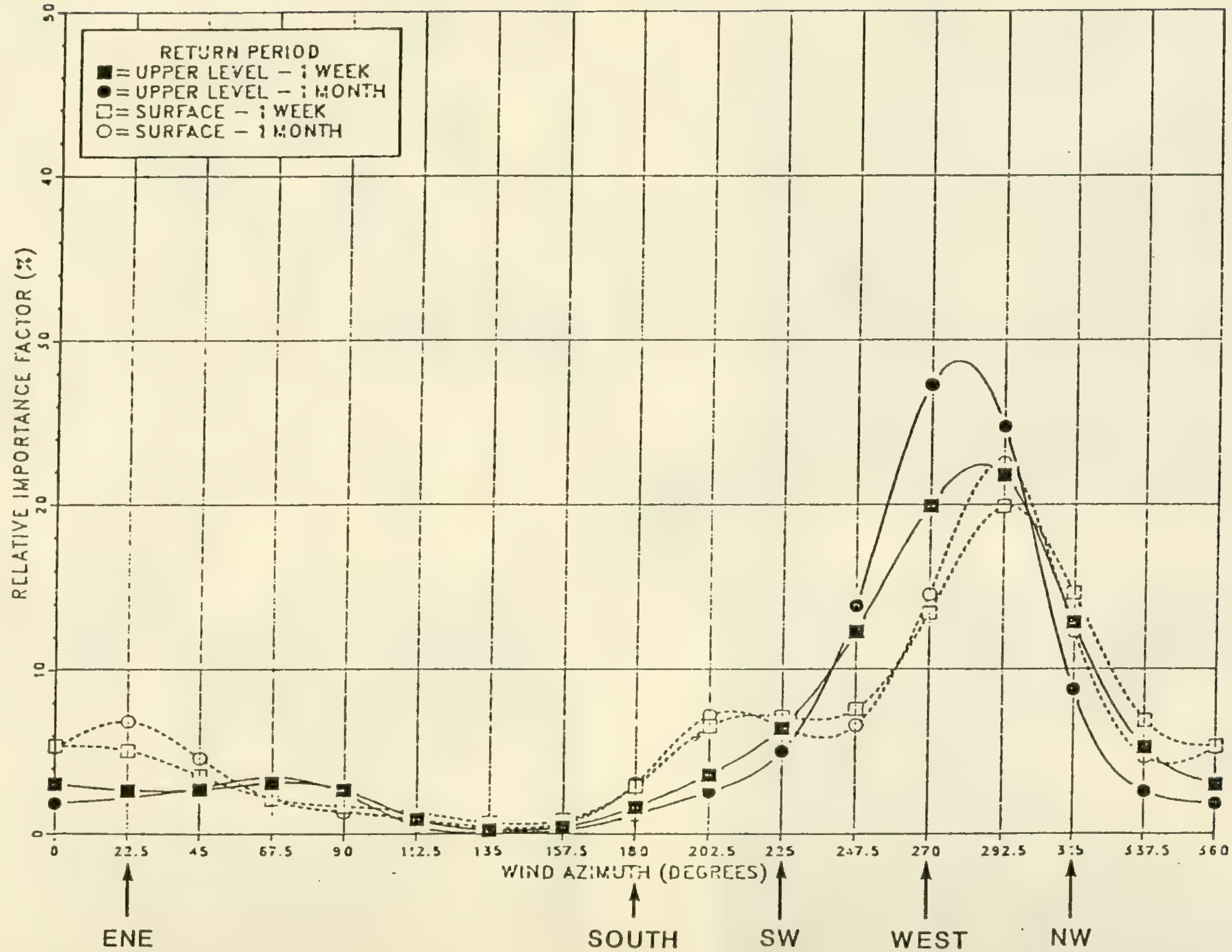
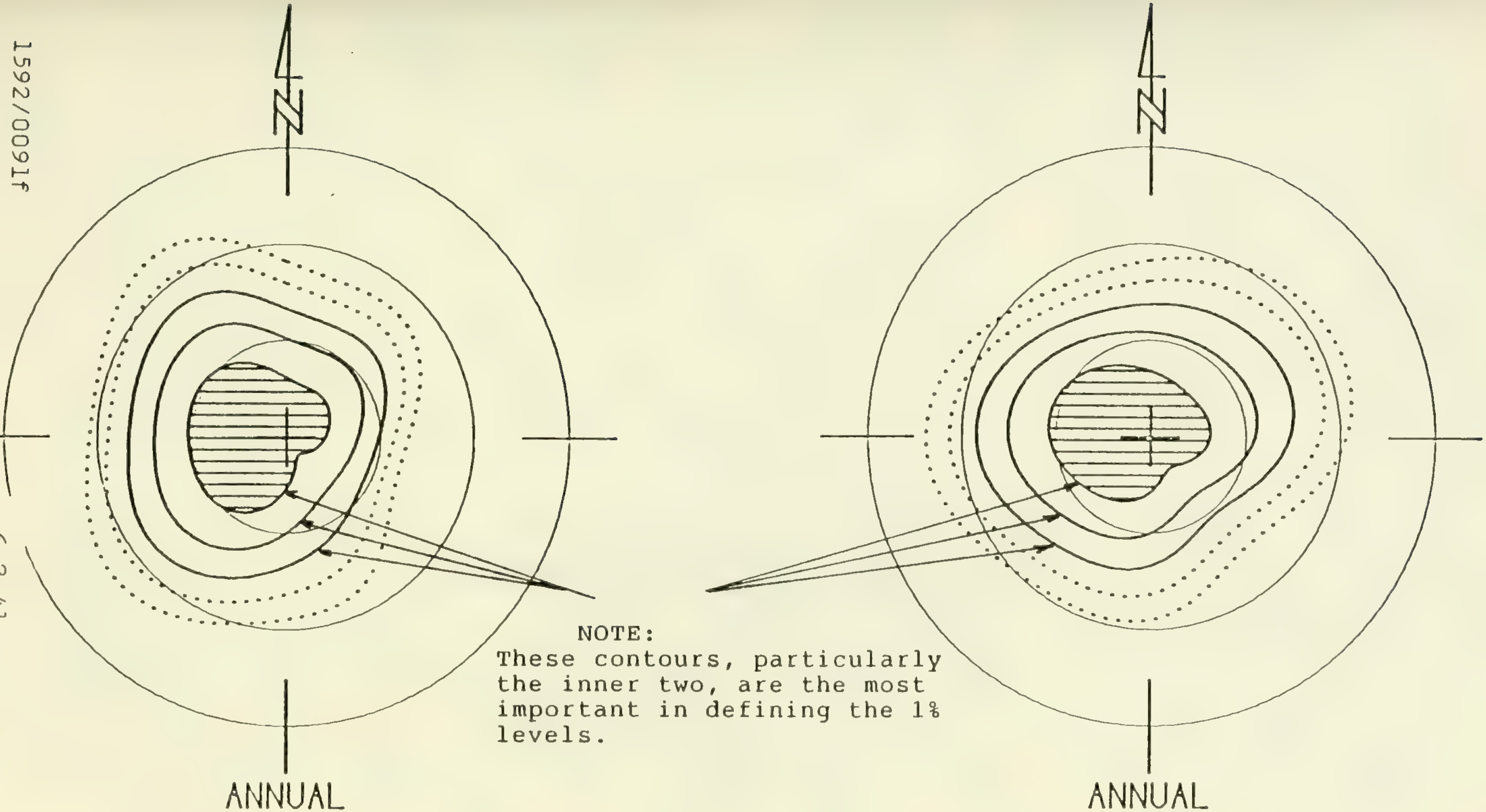


FIGURE 6.2-6a WIND DIRECTIONALITY ASSOCIATED WITH THE TWO WIND CLIMATE MODELS FOR BOSTON, MASS.



RADIAL DISTANCES INDICATE WIND SPEED IN MPH 0 40 80

CONTOURS SHOW WIND SPEEDS WHICH, FOR DIFFERENT DIRECTIONS, HAVE EQUAL PROBABILITY OF BEING EXCEEDED. THE PROBABILITY OF WIND SPEEDS LYING OUTSIDE THE HATCHED CONTOUR IS 1%. OTHER CONTOURS REPRESENT PROBABILITY LEVELS OF .1%, .01%, .001% AND .0001%, RESPECTIVELY. (per 22.5° sector)

MODEL I - Based directly on upper level pibal data (1945 - 1964)

RADIAL DISTANCES INDICATE WIND SPEED IN MPH 0 40 80

CONTOURS SHOW WIND SPEEDS WHICH, FOR DIFFERENT DIRECTIONS, HAVE EQUAL PROBABILITY OF BEING EXCEEDED. THE PROBABILITY OF WIND SPEEDS LYING OUTSIDE THE HATCHED CONTOUR IS 1%. OTHER CONTOURS REPRESENT PROBABILITY LEVELS OF .1%, .01%, .001% AND .0001%, RESPECTIVELY. (per 22.5° sector)

MODEL II - Based on corrected surface data (1945 - 1983)

FIGURE 6.2-6b ANNUAL PROBABILITY DISTRIBUTIONS OF GRADIENT WIND SPEED AND DIRECTION FOR THE TWO WIND CLIMATE MODELS FOR BOSTON

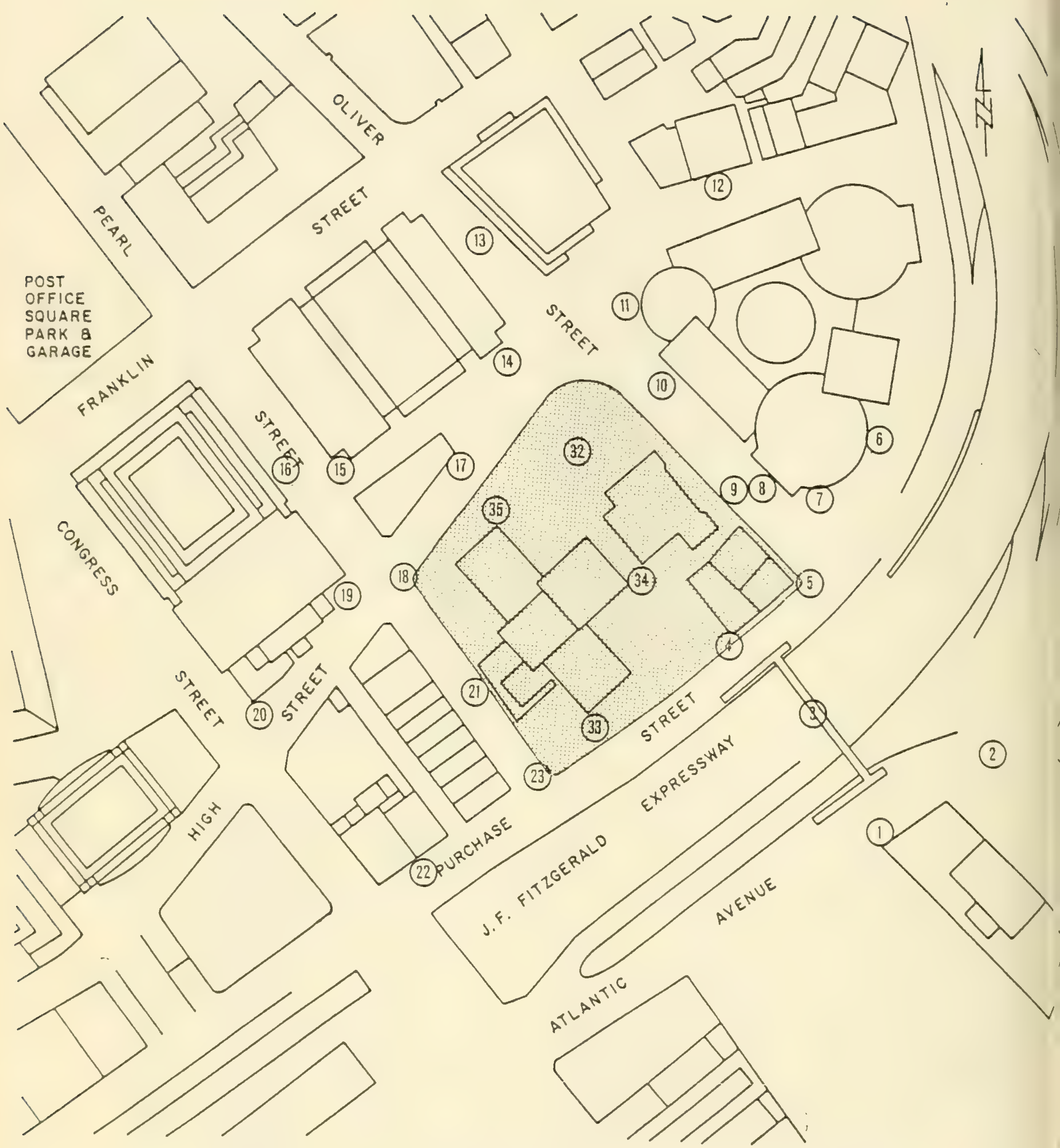


FIGURE 6.2-7a SUGGESTED LOCATIONS FOR QUANTITATIVE WIND SPEED MEASUREMENTS, CURRENT SITE CONFIGURATION

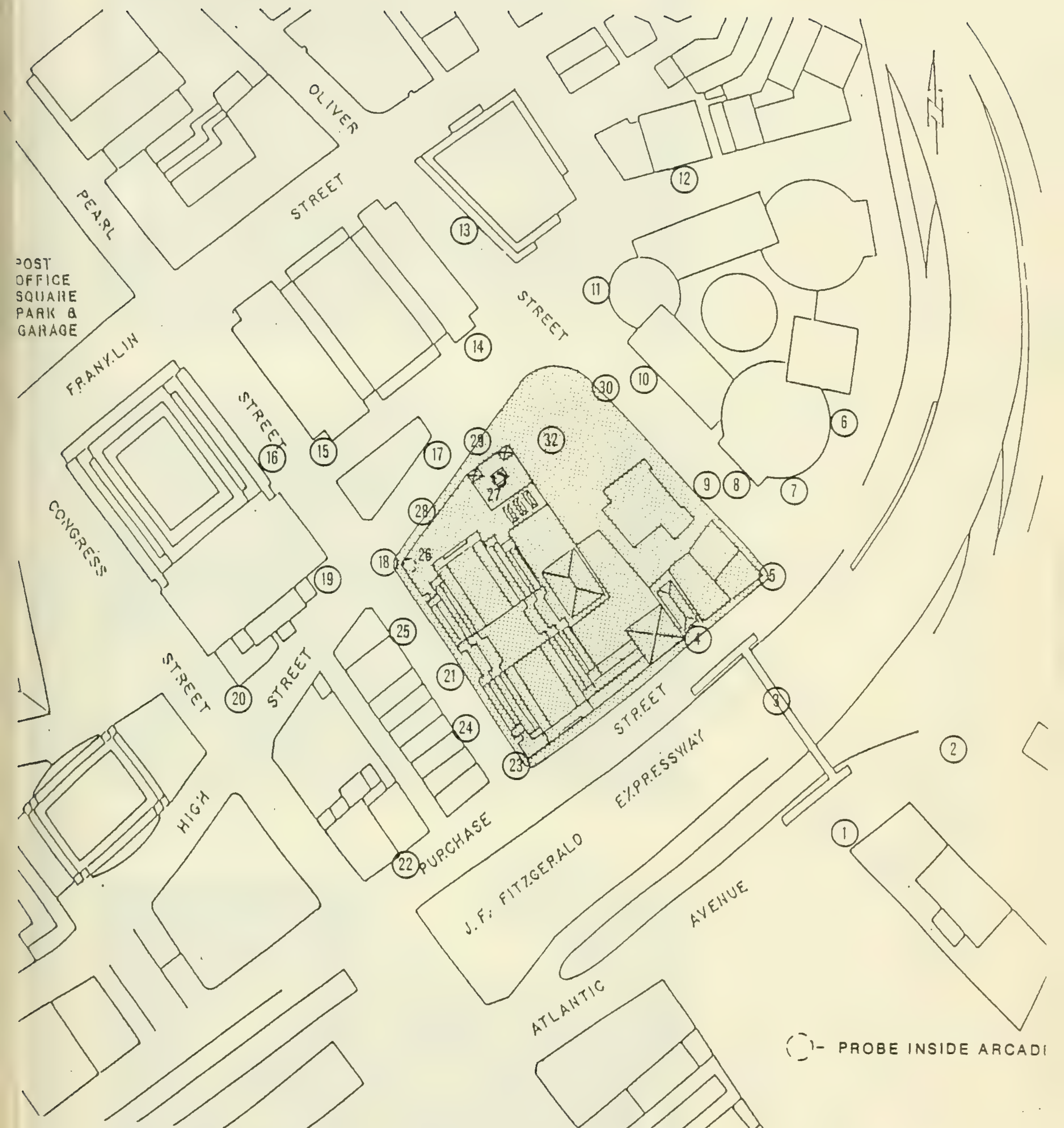


FIGURE 6.2-7b SUGGESTED LOCATIONS FOR QUANTITATIVE WIND SPEED MEASUREMENTS, 30-STORY BUILDING

1592/0091f

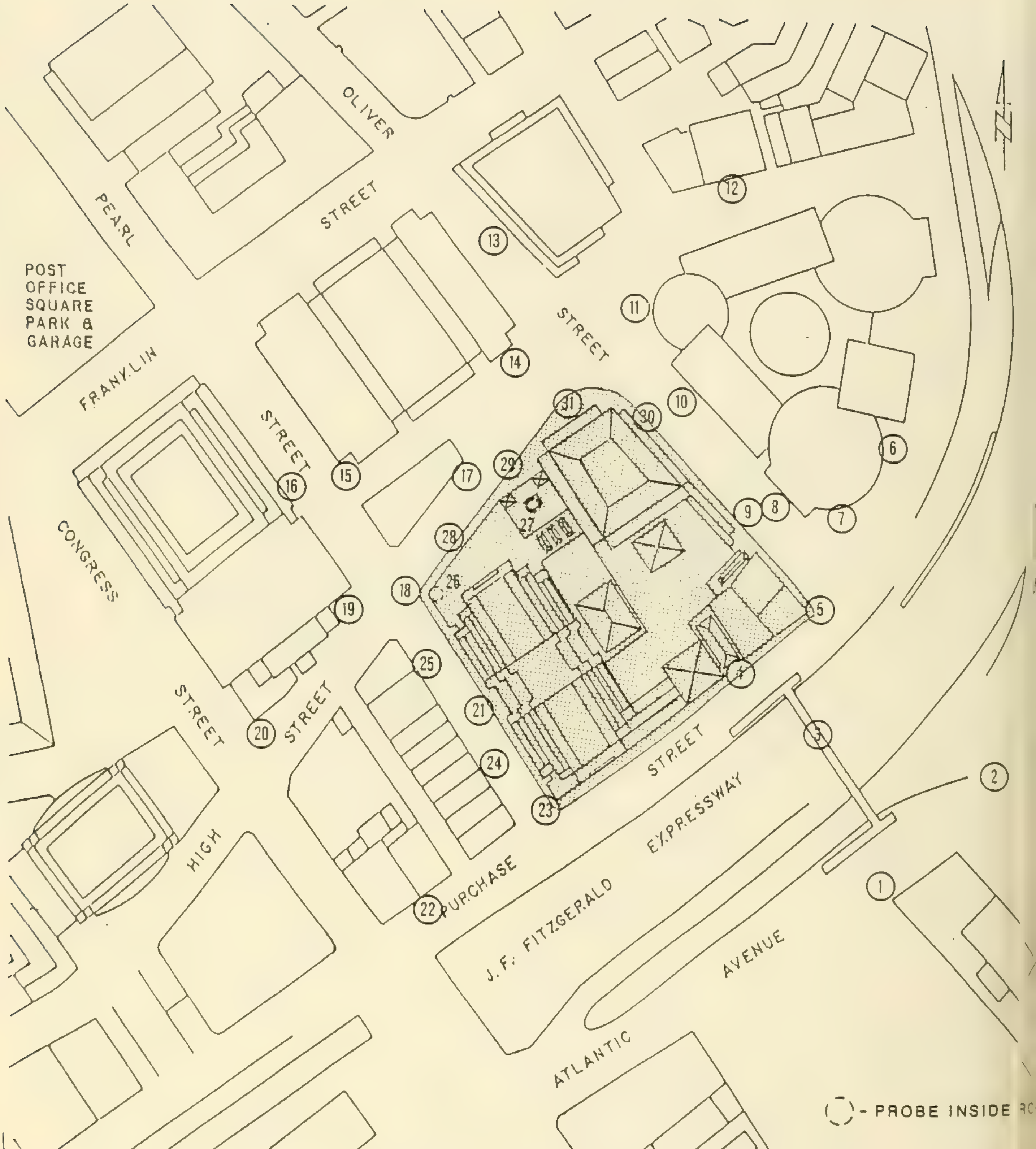
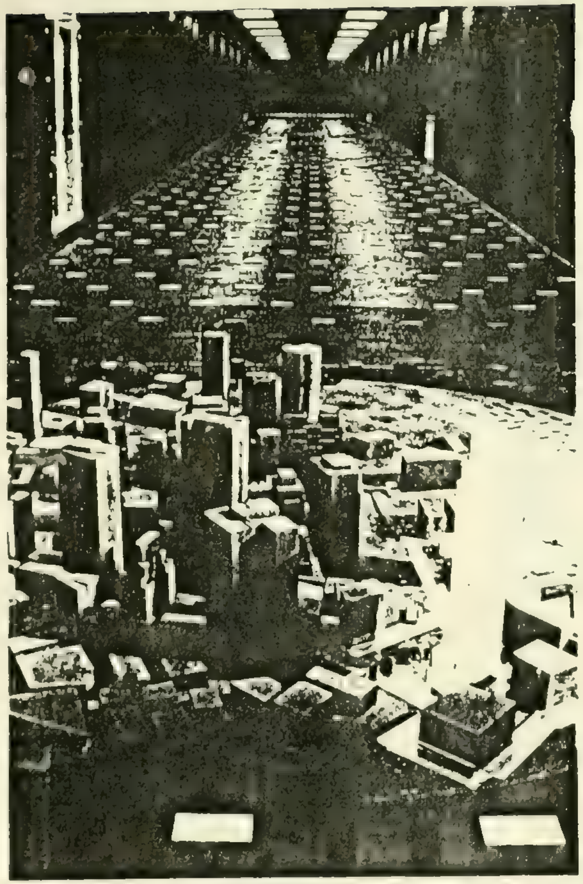
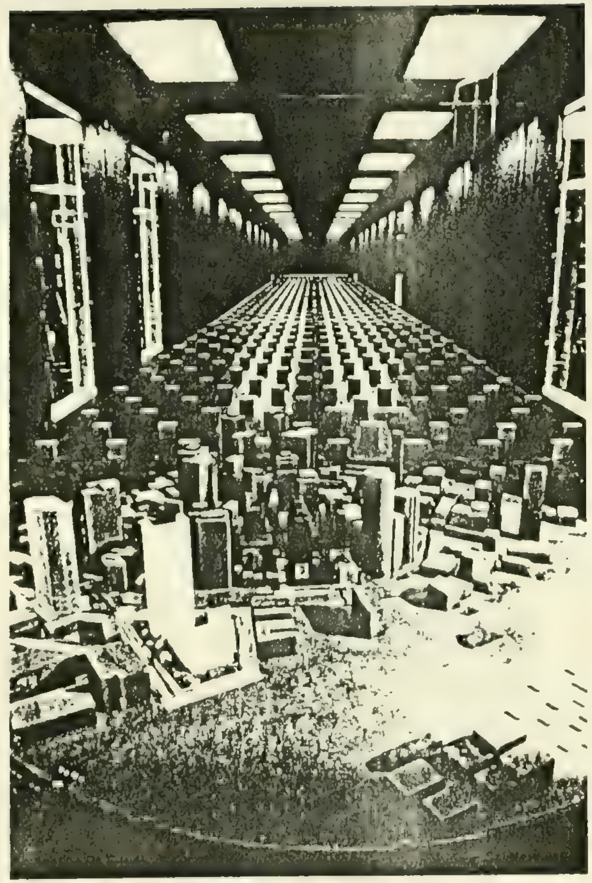


FIGURE 6.2-7c SUGGESTED LOCATIONS FOR QUANTITATIVE WIND SPEED MEASUREMENTS, 30-STORY AND 21-STORY BUILDINGS (FULL DEVELOPMENT)

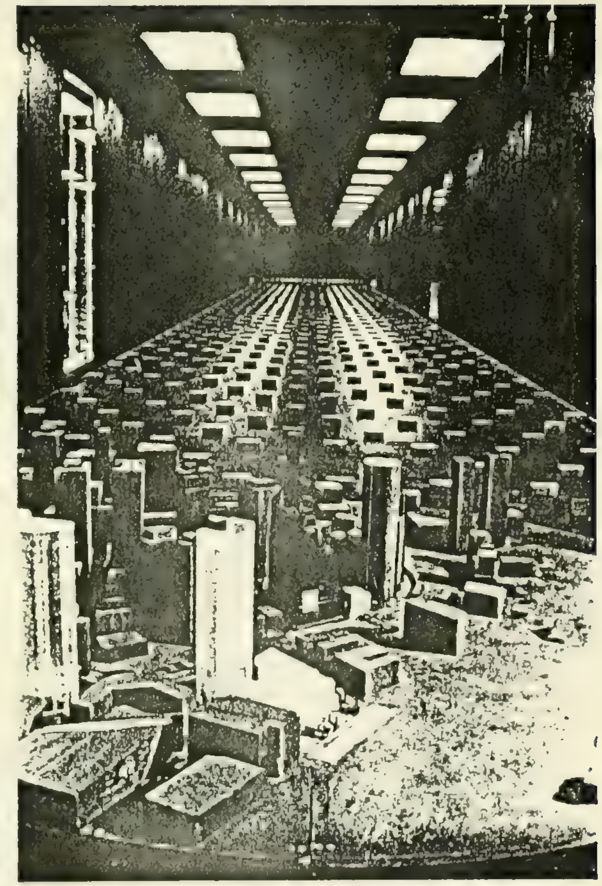
1592/0091f



EXPOSURE 1



EXPOSURE 2



EXPOSURE 3

FIGURE 6.2-8 WIND PROFILE EXPOSURES

FIGURE 6.2-9 AZIMUTH RANGES FOR WHICH THE THREE EXPOSURES WERE USED

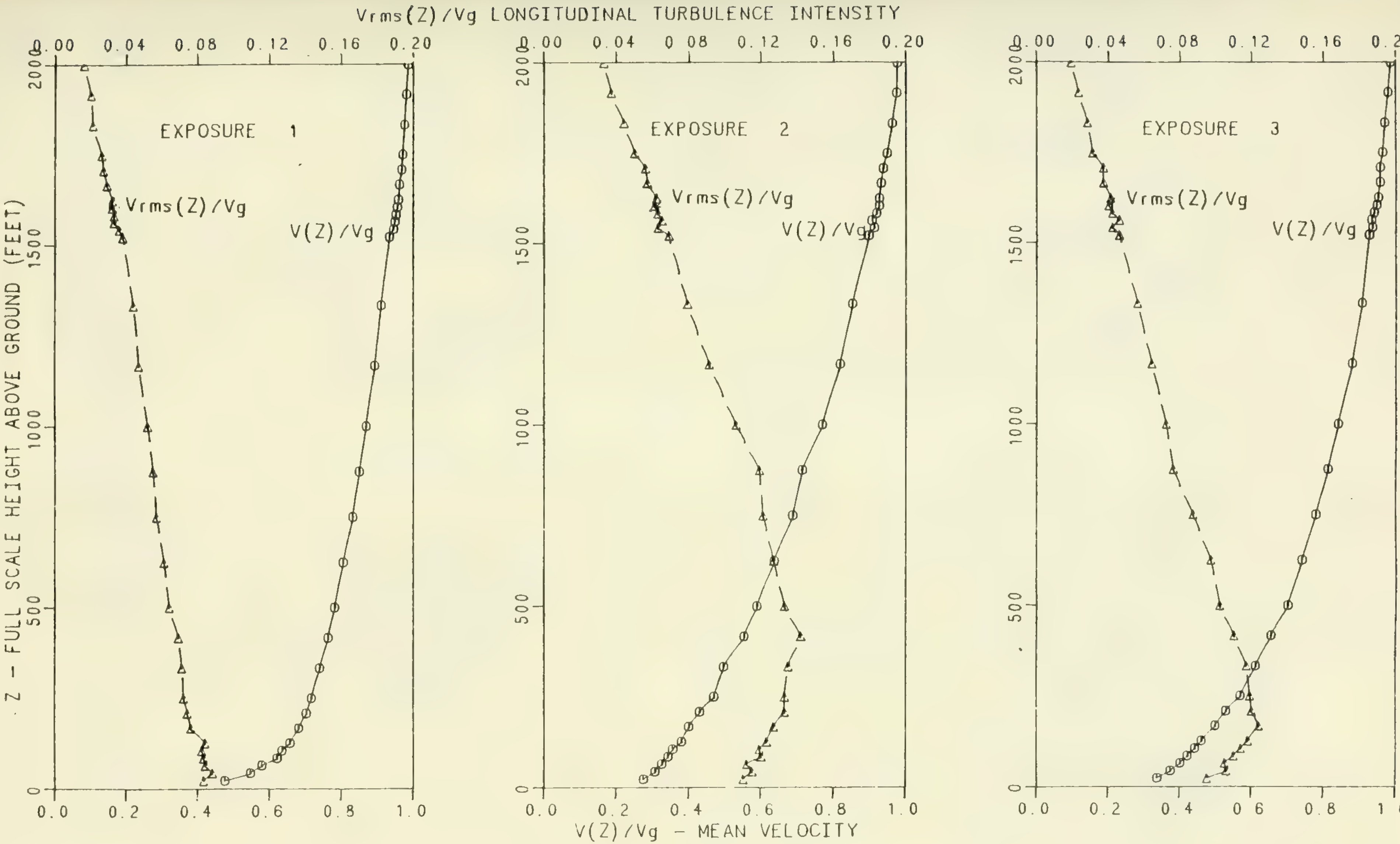


FIGURE 6.2-10 VERTICAL PROFILES OF THE MEAN SPEED AND THE LONGITUDINAL TURBULENCE INTENSITY FOR THE THREE EXPOSURES USED

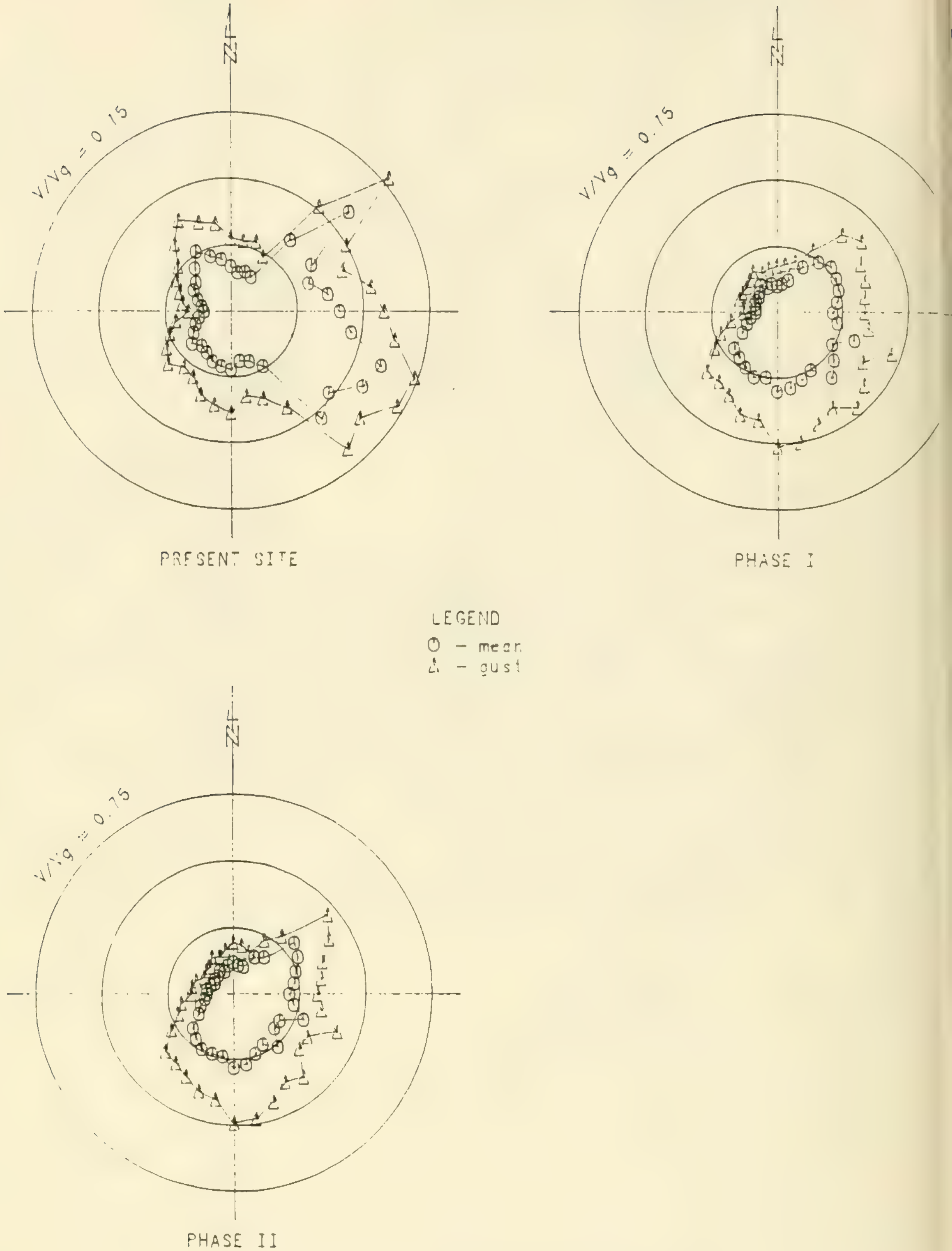


FIGURE 6.2-11a EXAMPLE OF MEASURED MEAN AND MAXIMUM WIND SPEED COEFFICIENTS FOR LOCATION 4

(Maximum Speed = Mean Speed + 1.5 Standard Deviation)

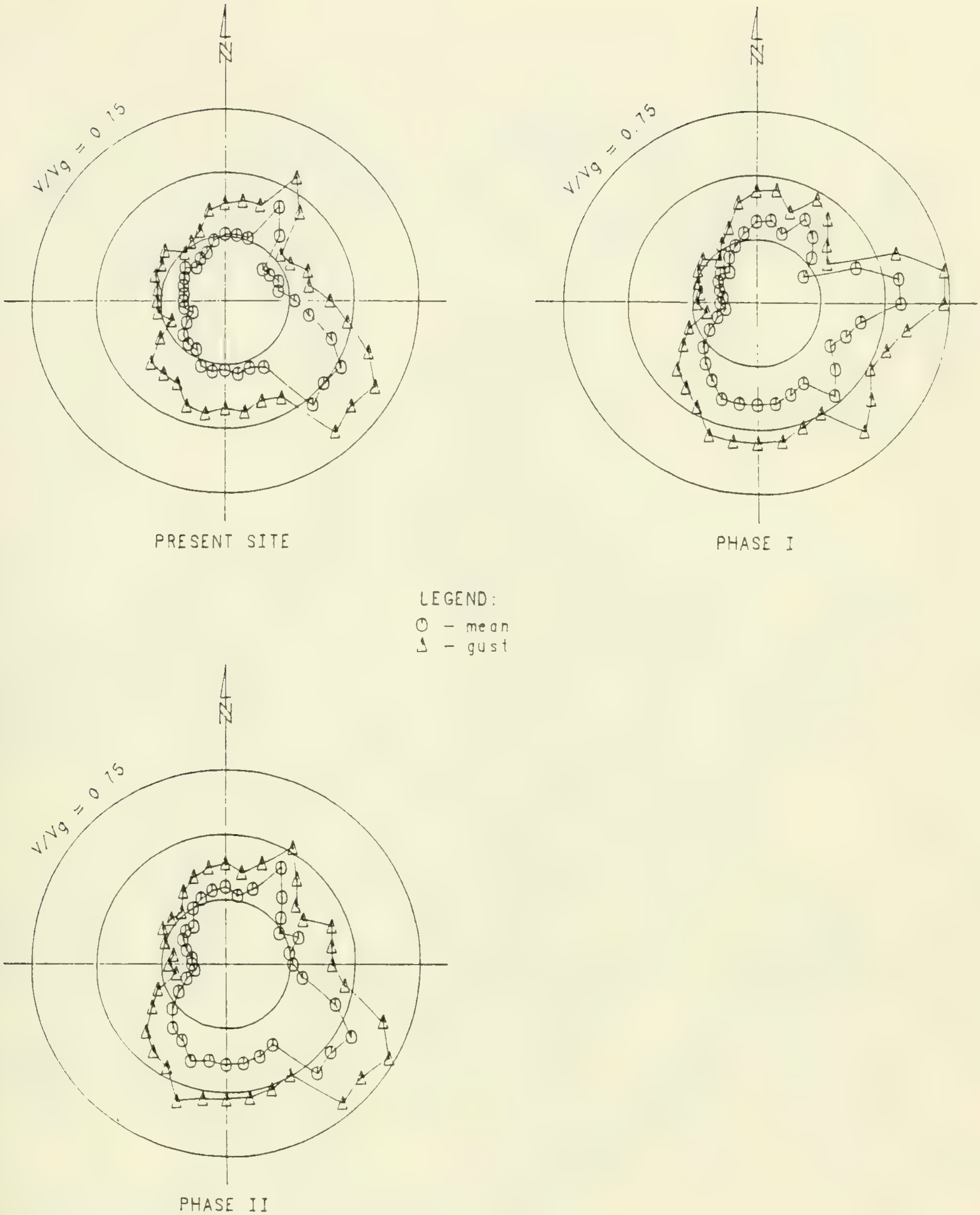


FIGURE 6.2-11b EXAMPLE OF MEASURED MEAN AND MAXIMUM WIND SPEED COEFFICIENTS FOR LOCATION 18
(Maximum Speed = Mean Speed + 1.5 Standard Deviation)

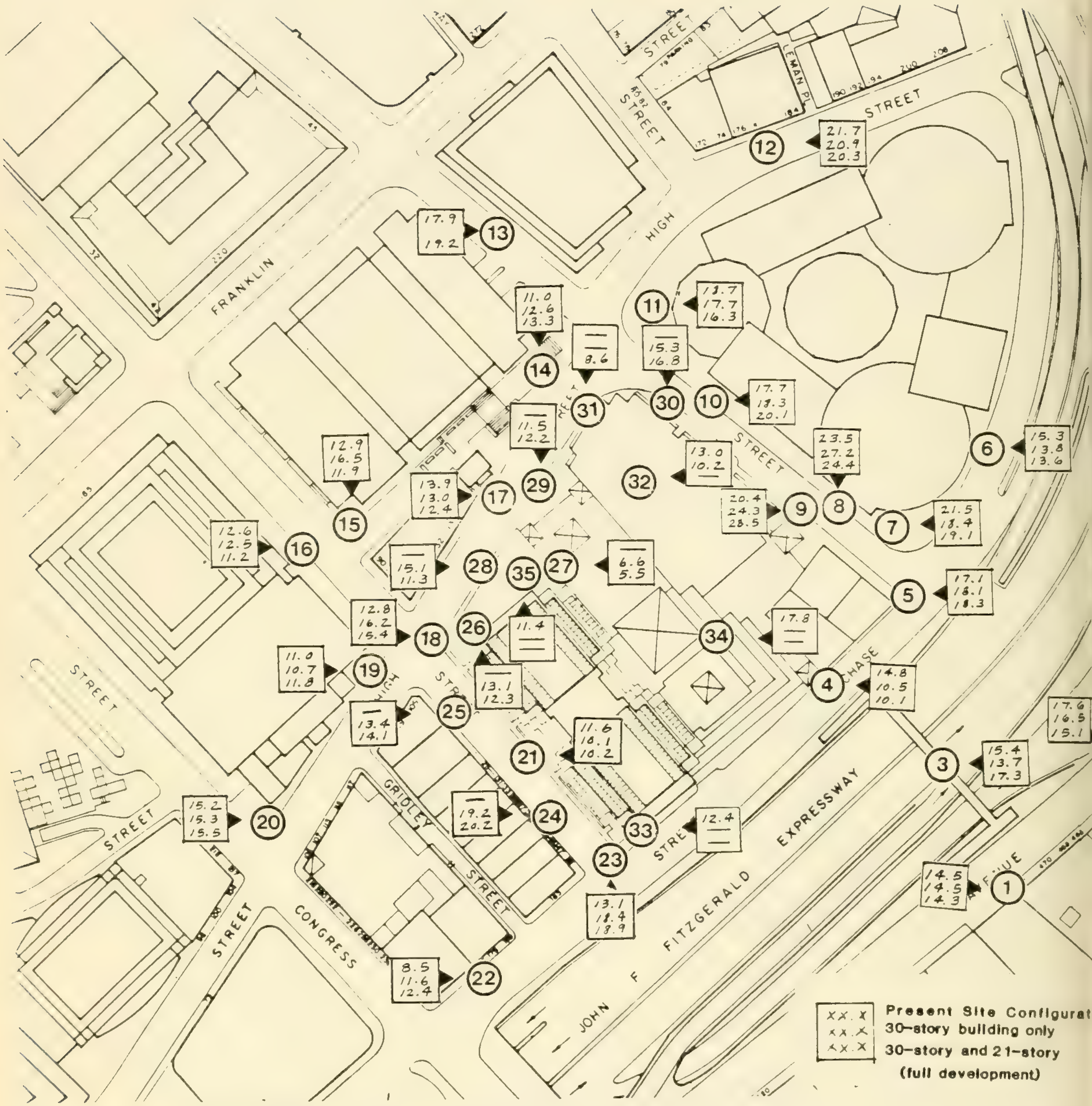


FIGURE 6.2-12a MEAN WIND SPEEDS EXCEEDED 1% OF THE TIME

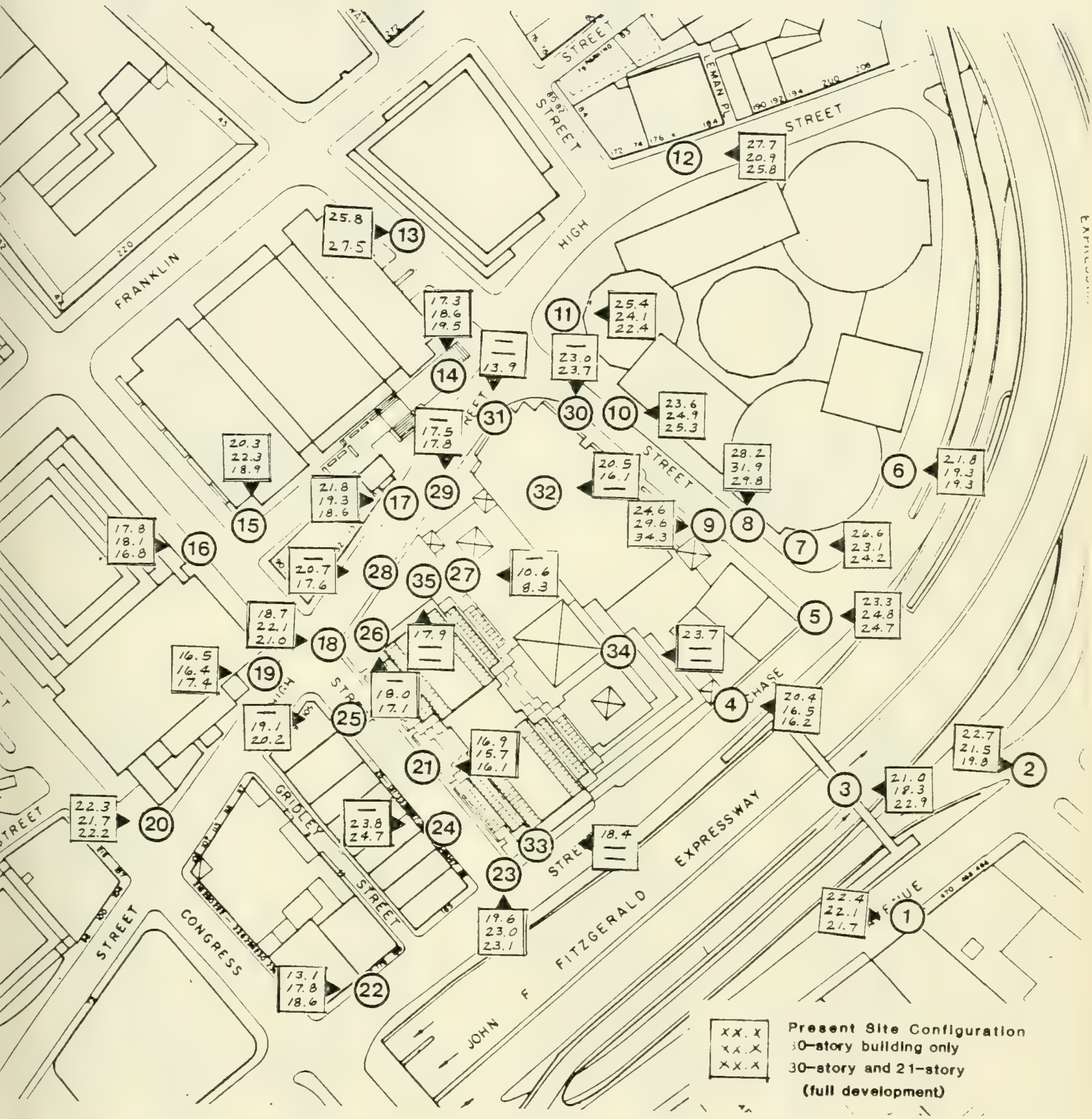
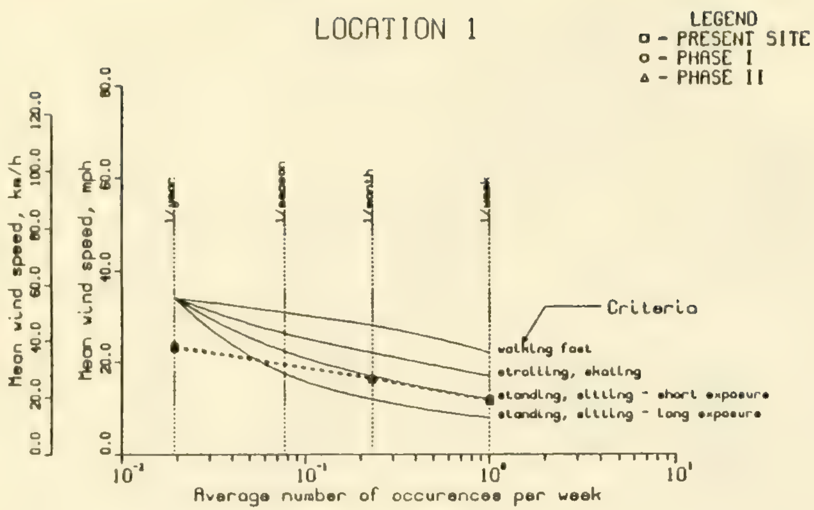
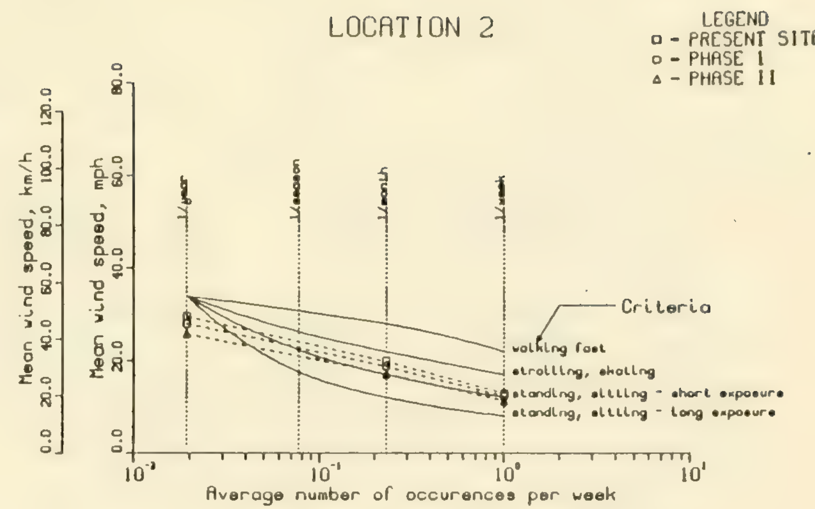
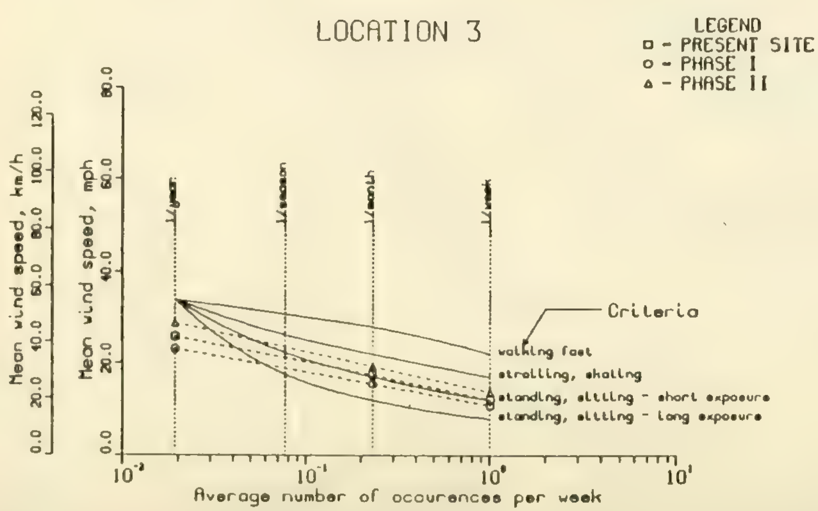
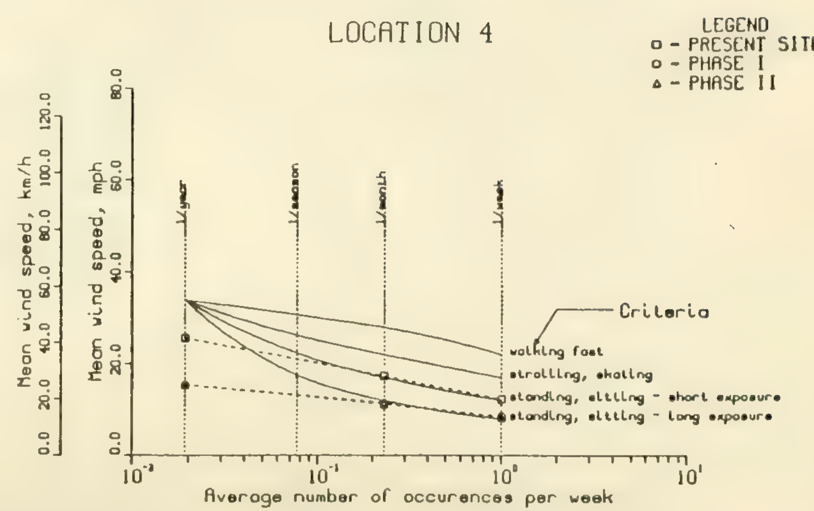


FIGURE 6.2-12b GUST VELOCITIES EXCEEDED 1% OF THE TIME


LOCATION 1
LEGEND
□ - PRESENT SITE
○ - PHASE I
△ - PHASE II
Mean wind speed, km/h
Mean wind speed, mph
1/year
1/season
1/month
1/week
Criteria
walking fast
strolling, skating
standing, sitting - short exposure
standing, sitting - long exposure
Average number of occurences per week


LOCATION 2
LEGEND
□ - PRESENT SITE
○ - PHASE I
△ - PHASE II
Mean wind speed, km/h
Mean wind speed, mph
1/year
1/season
1/month
1/week
Criteria
walking fast
strolling, skating
standing, sitting - short exposure
standing, sitting - long exposure
Average number of occurences per week


LOCATION 3
LEGEND
□ - PRESENT SITE
○ - PHASE I
△ - PHASE II
Mean wind speed, km/h
Mean wind speed, mph
1/year
1/season
1/month
1/week
Criteria
walking fast
strolling, skating
standing, sitting - short exposure
standing, sitting - long exposure
Average number of occurences per week


LOCATION 4
LEGEND
□ - PRESENT SITE
○ - PHASE I
△ - PHASE II
Mean wind speed, km/h
Mean wind speed, mph
1/year
1/season
1/month
1/week
Criteria
walking fast
strolling, skating
standing, sitting - short exposure
standing, sitting - long exposure
Average number of occurences per week

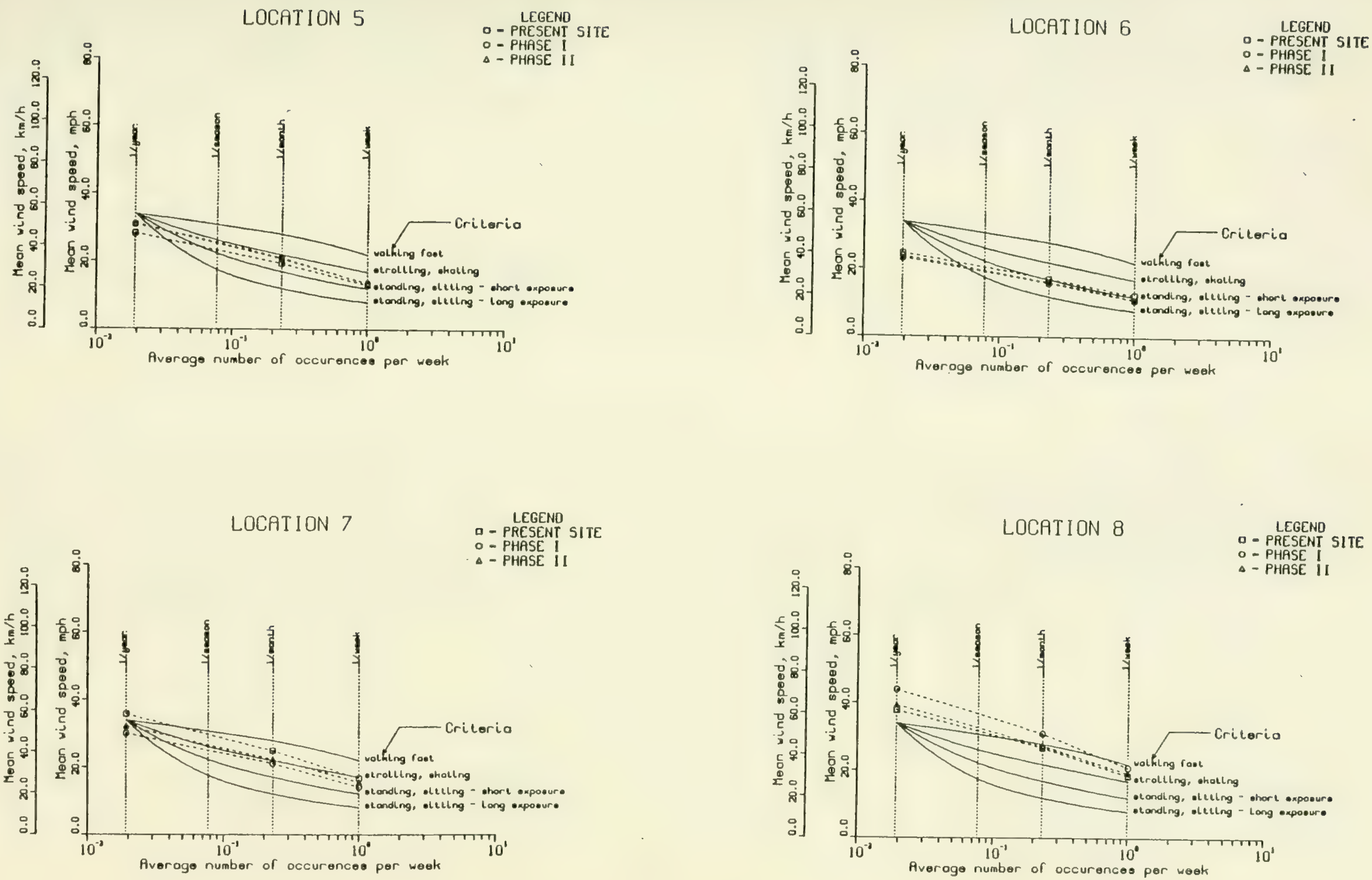
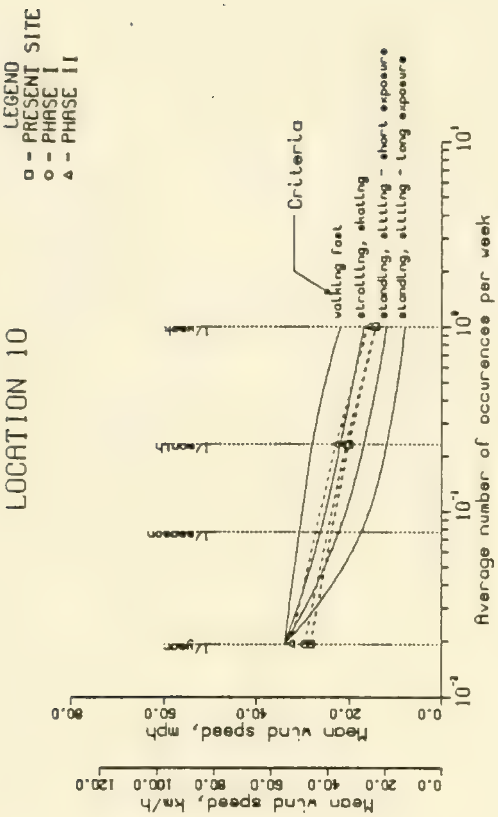
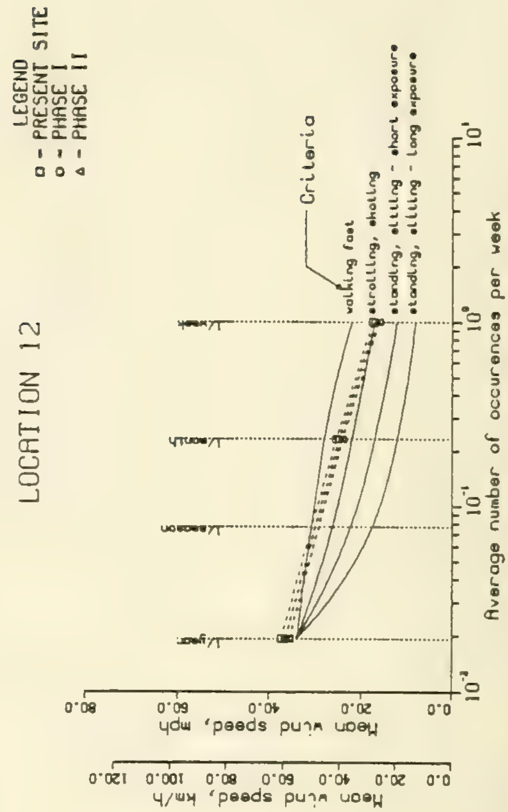
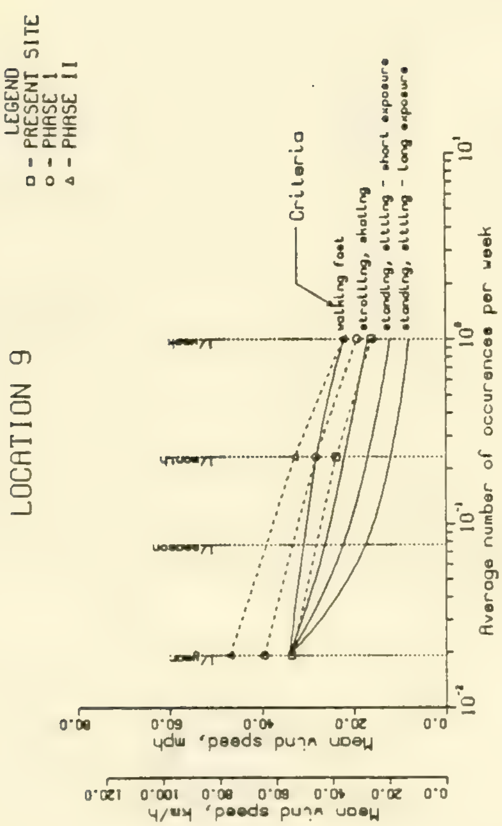
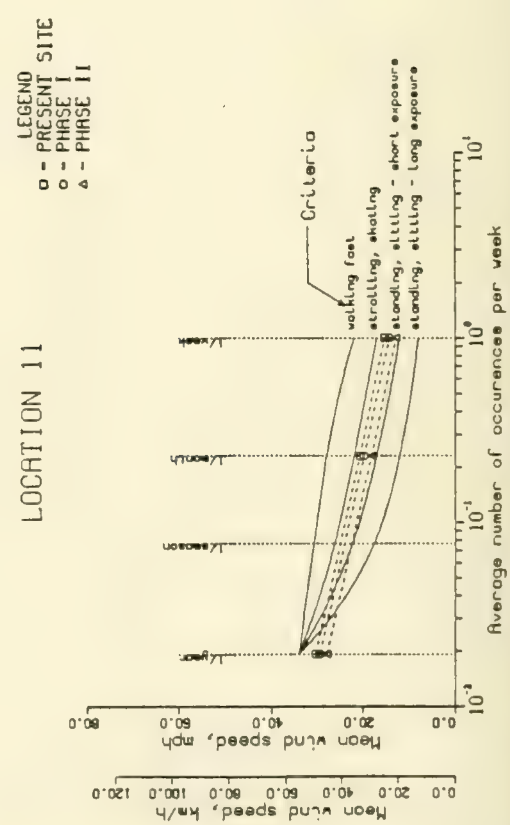


FIGURE 6.2-13b MEAN WIND SPEEDS EXCEEDED FOR VARIOUS ANNUAL FREQUENCIES OF OCCURRENCE


LOCATION 10
LEGEND
□ - PRESENT SITE
○ - PHASE I
△ - PHASE II
Criteria
walking fast
strolling, skating
standing, sitting - short exposure
standing, sitting - long exposure
Average number of occurences per week
Mean wind speed, mph
Mean wind speed, km/h


LOCATION 12
LEGEND
□ - PRESENT SITE
○ - PHASE I
△ - PHASE II
Criteria
walking fast
strolling, skating
standing, sitting - short exposure
standing, sitting - long exposure
Average number of occurences per week
Mean wind speed, mph
Mean wind speed, km/h


LOCATION 9
LEGEND
□ - PRESENT SITE
○ - PHASE I
△ - PHASE II
Criteria
walking fast
strolling, skating
standing, sitting - short exposure
standing, sitting - long exposure
Average number of occurences per week
Mean wind speed, mph
Mean wind speed, km/h


LOCATION 11
LEGEND
□ - PRESENT SITE
○ - PHASE I
△ - PHASE II
Criteria
walking fast
strolling, skating
standing, sitting - short exposure
standing, sitting - long exposure
Average number of occurences per week
Mean wind speed, mph
Mean wind speed, km/h

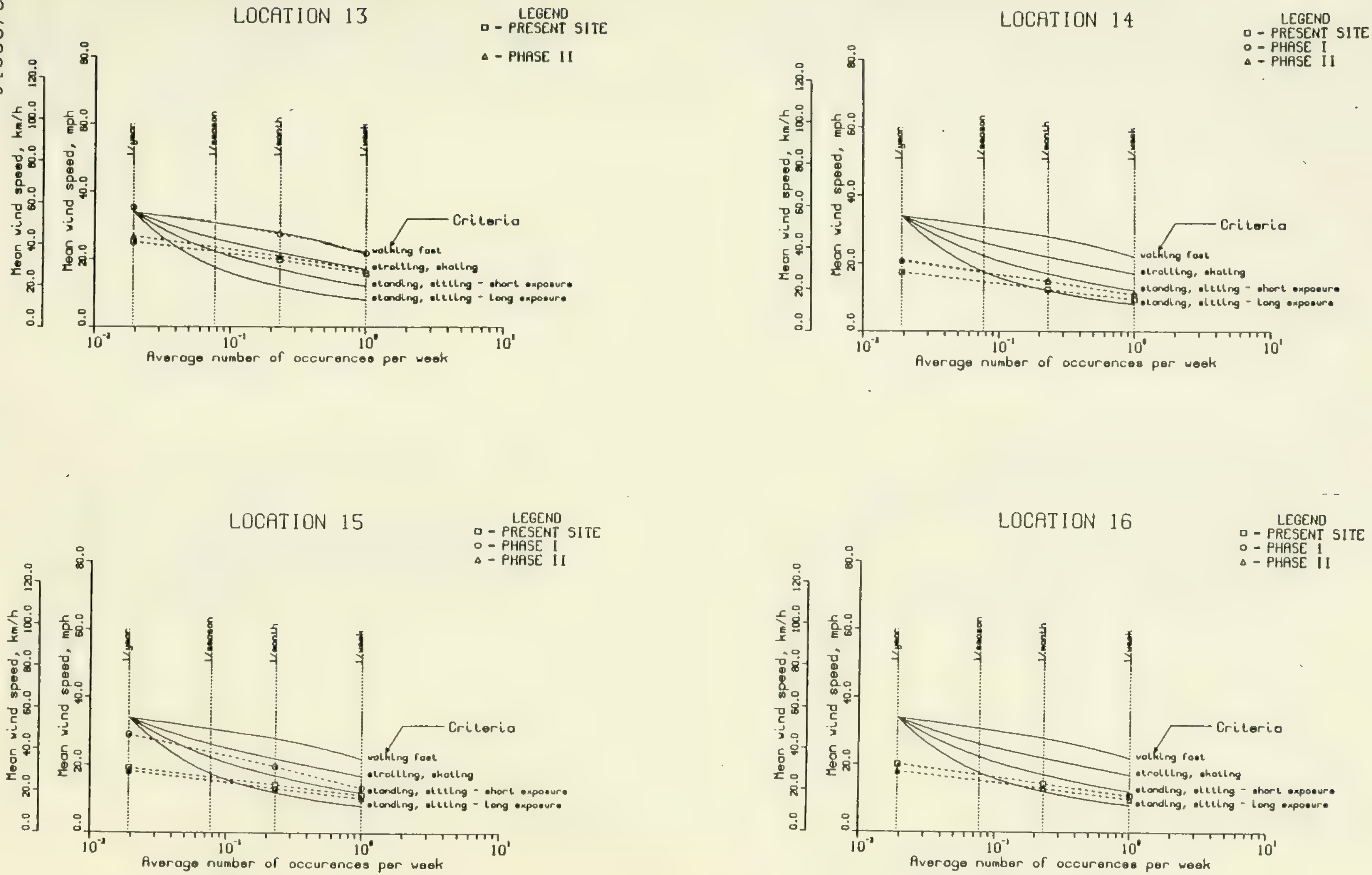


FIGURE 6.2-13d MEAN WIND SPEEDS EXCEEDED FOR VARIOUS ANNUAL FREQUENCIES OF OCCURRENCE

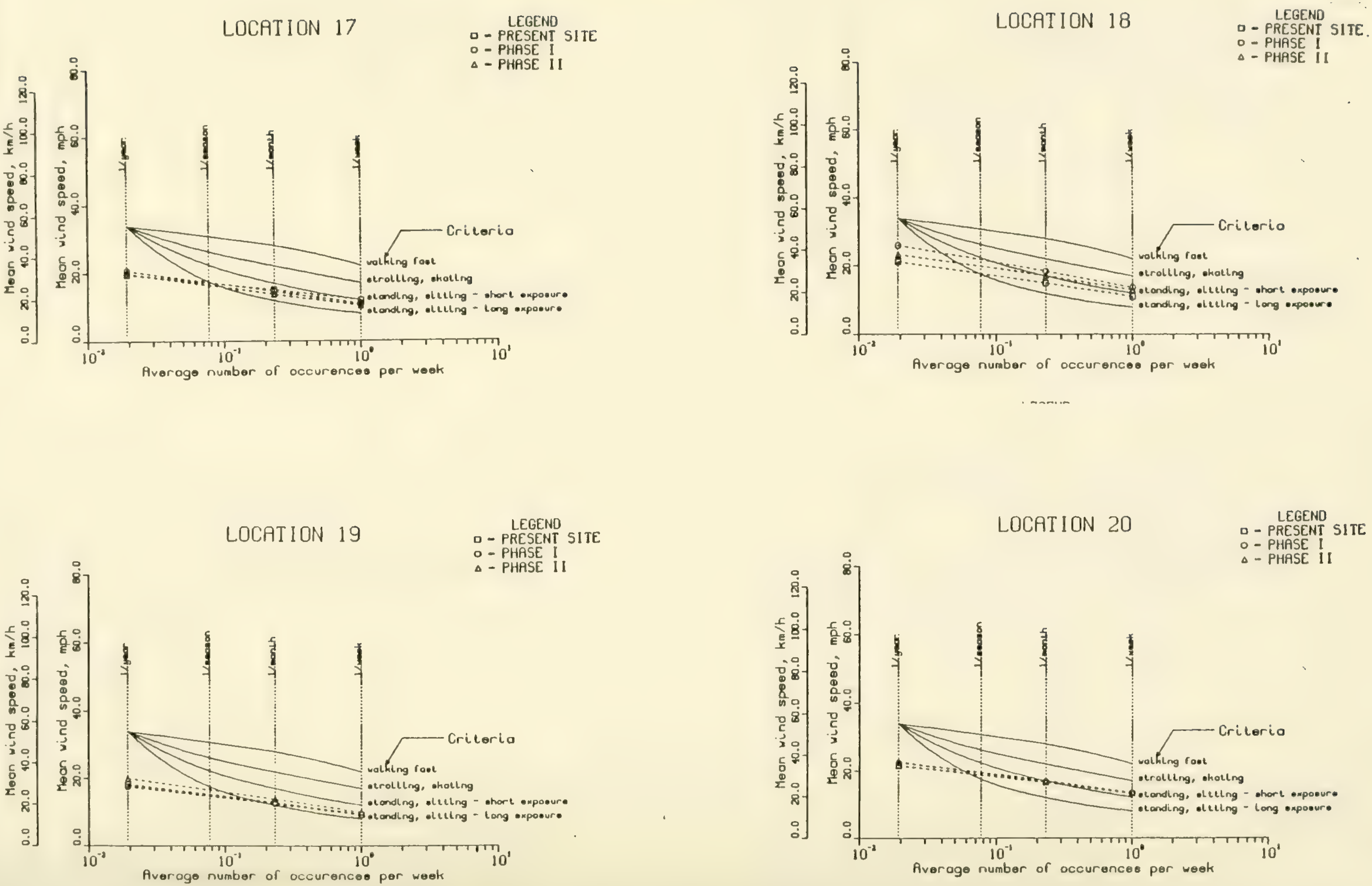


FIGURE 6.2-13e MEAN WIND SPEEDS EXCEEDED FOR VARIOUS ANNUAL

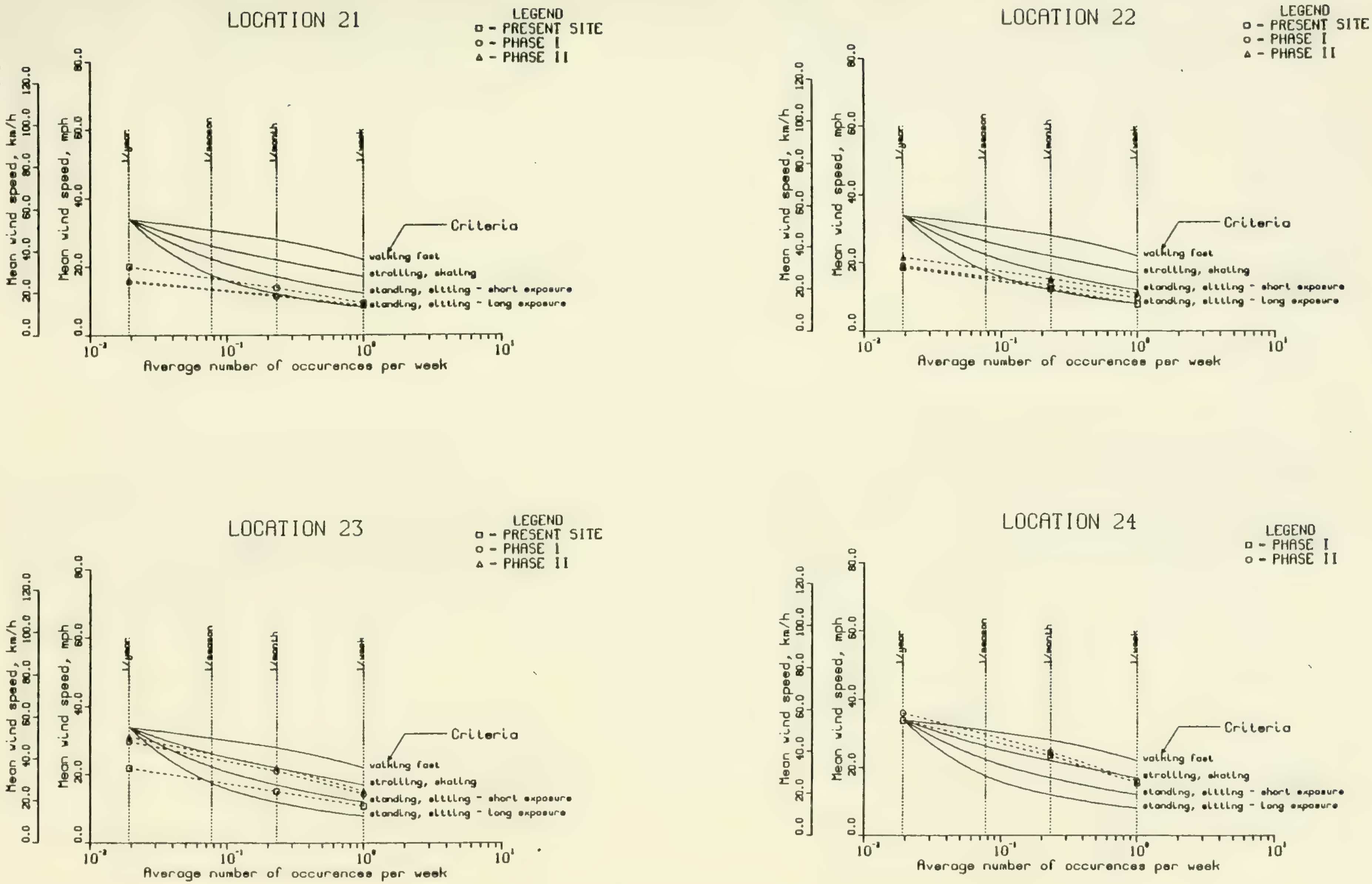
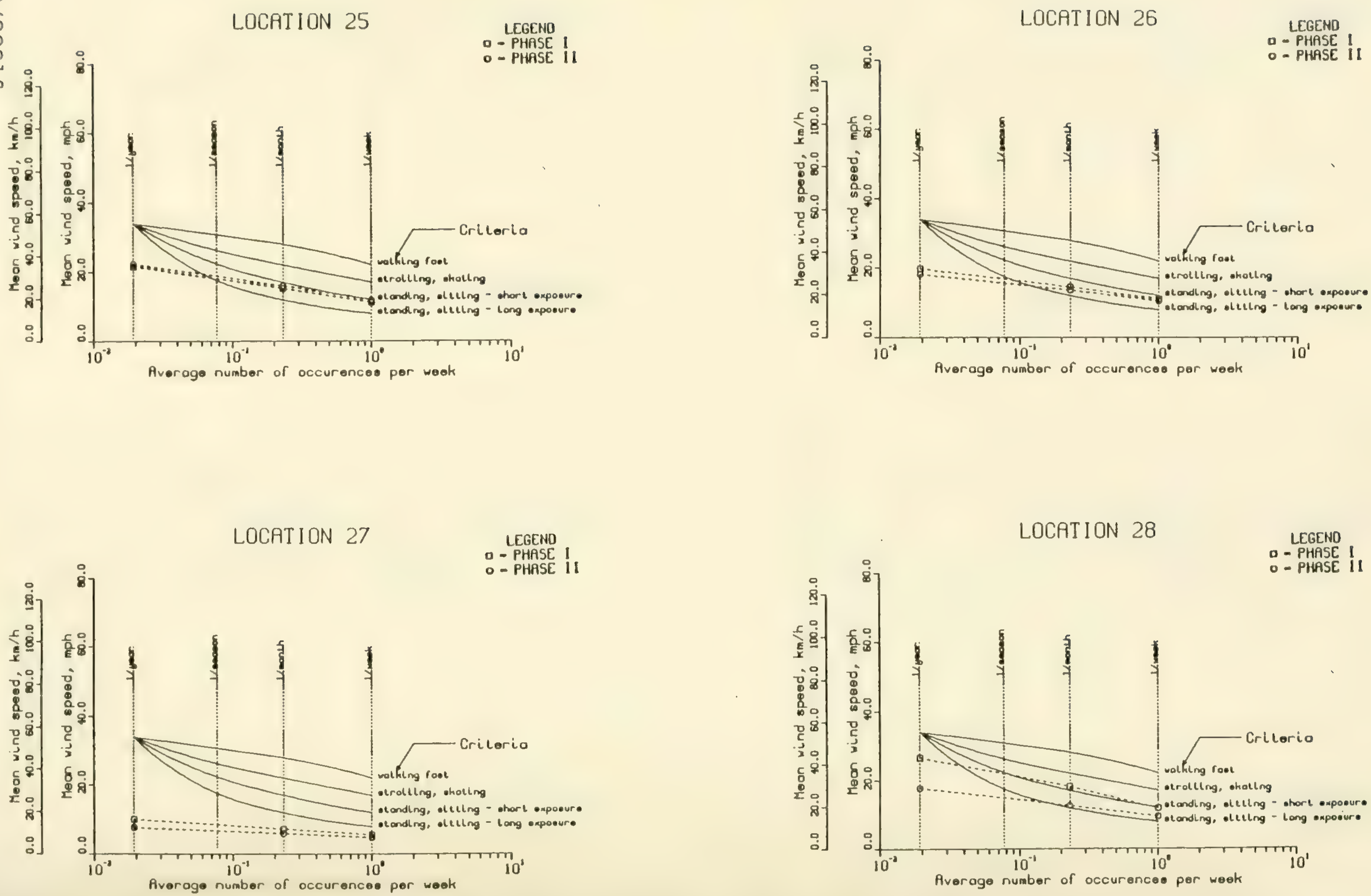


FIGURE 6.2-13f MEAN WIND SPEEDS EXCEEDED FOR VARIOUS ANNUAL FREQUENCIES OF OCCURRENCE


LOCATION 25
LEGEND
□ - PHASE I
○ - PHASE II
Mean wind speed, km/h
Mean wind speed, mph
Criteria
walking fast
strolling, skating
standing, sitting - short exposure
standing, sitting - long exposure
Average number of occurences per week
LOCATION 26
LOCATION 27
LOCATION 28

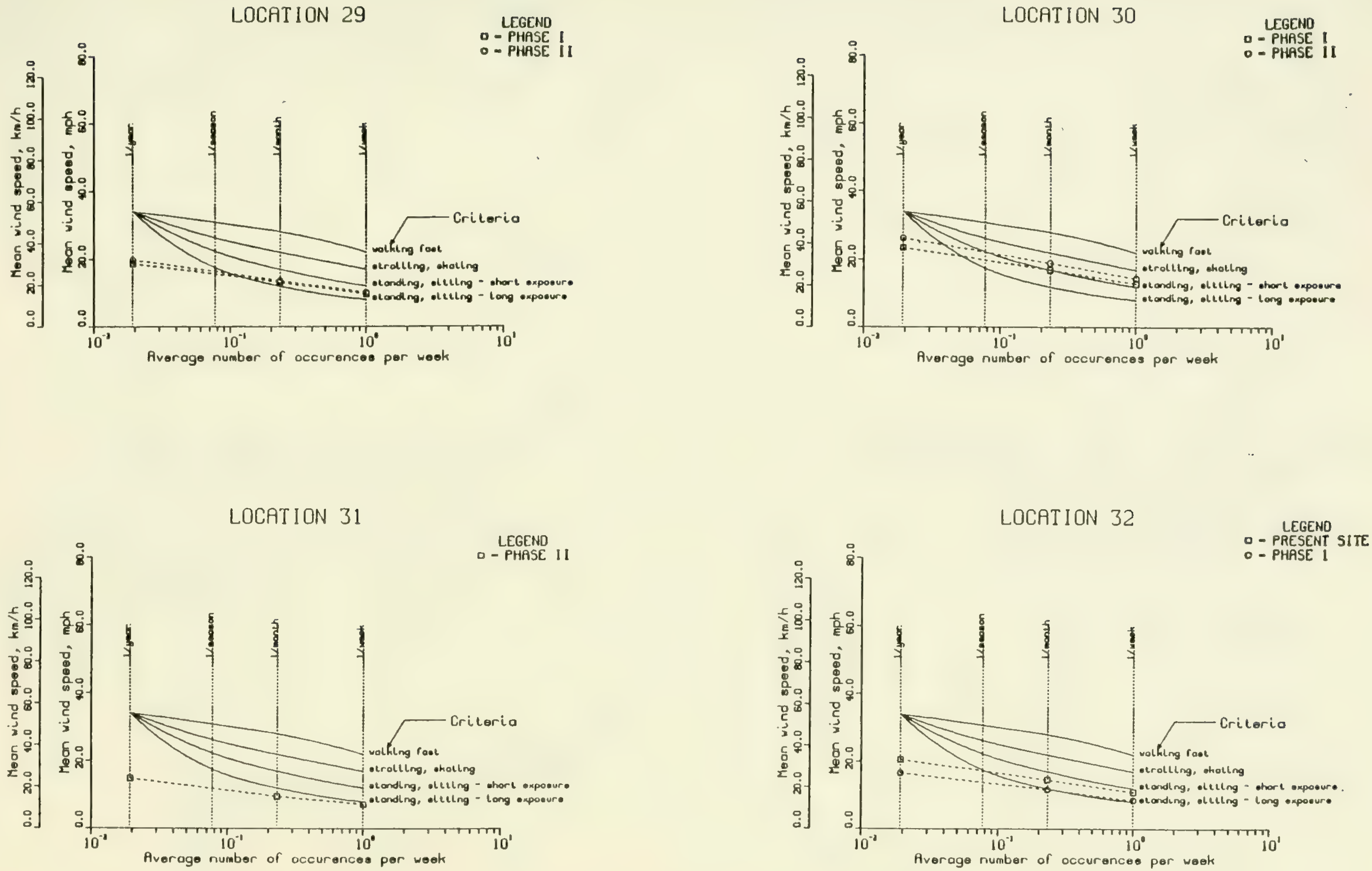
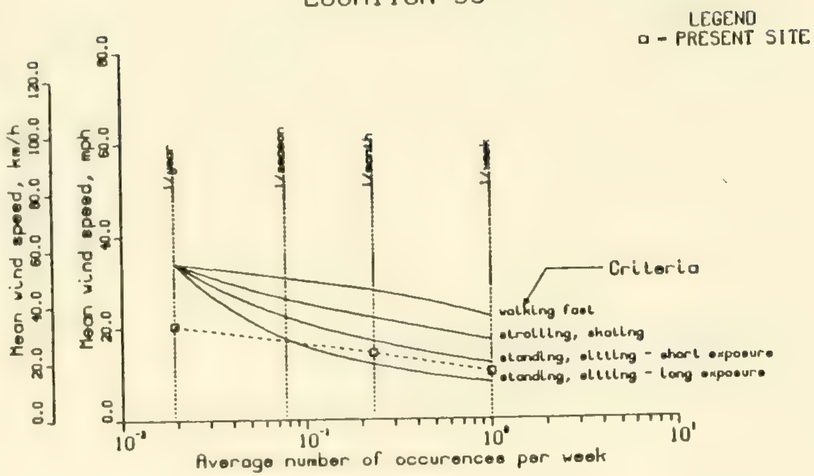
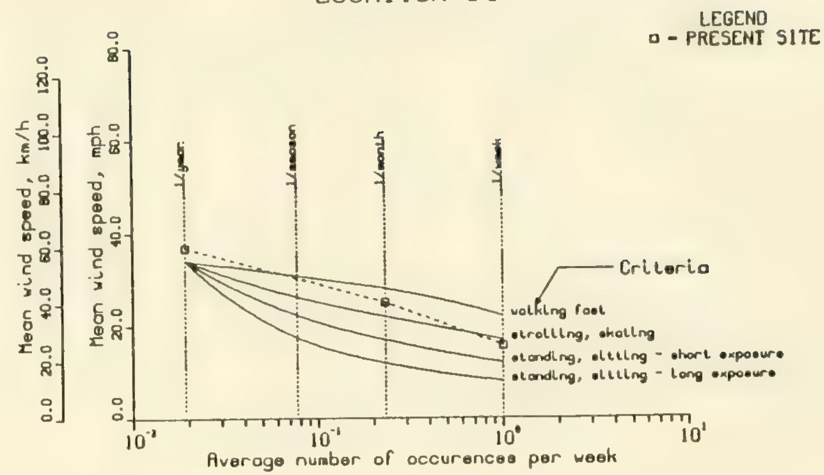


FIGURE 6.2-13h MEAN WIND SPEEDS EXCEEDED FOR VARIOUS ANNUAL FREQUENCIES OF OCCURRENCE

LOCATION 33



LOCATION 34



LOCATION 35

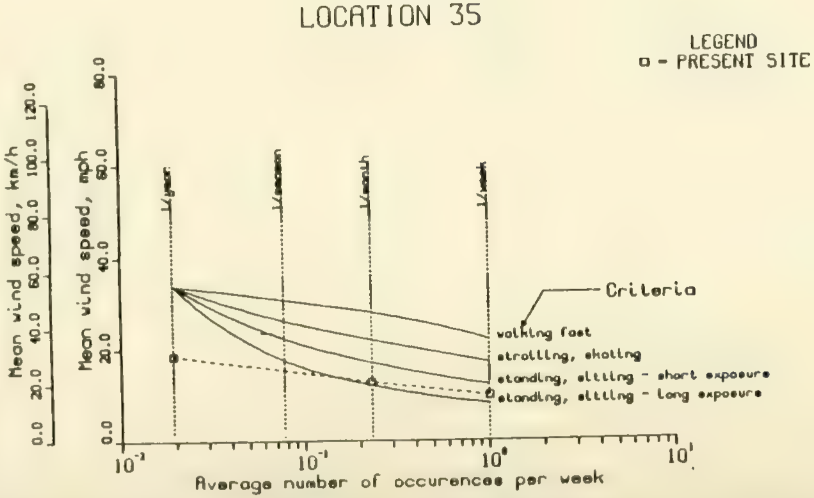


FIGURE 6.2-13i MEAN WIND SPEEDS EXCEEDED FOR VARIOUS ANNUAL FREQUENCIES OF OCCURRENCE

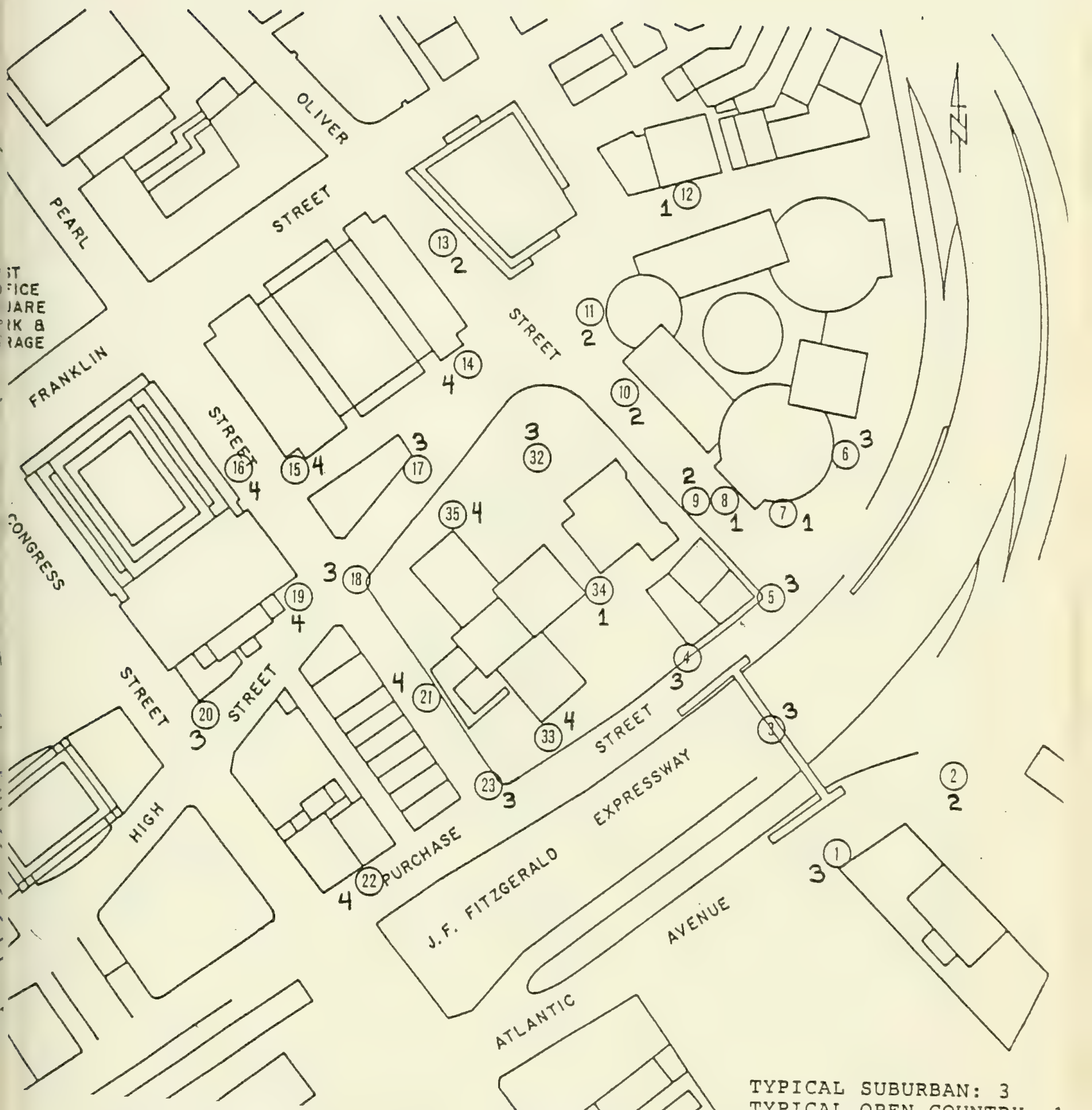


FIGURE 6.2-14a STORM EVENT CLASSIFICATION OF THE RESULTS BY ACTIVITY NUMBER FOR THE PRESENT SITE (1 = 25-31 mph; 2 = 20-24 mph; 3 = 15-19 mph, 4 = 10-14 mph; 1 occassion per month)

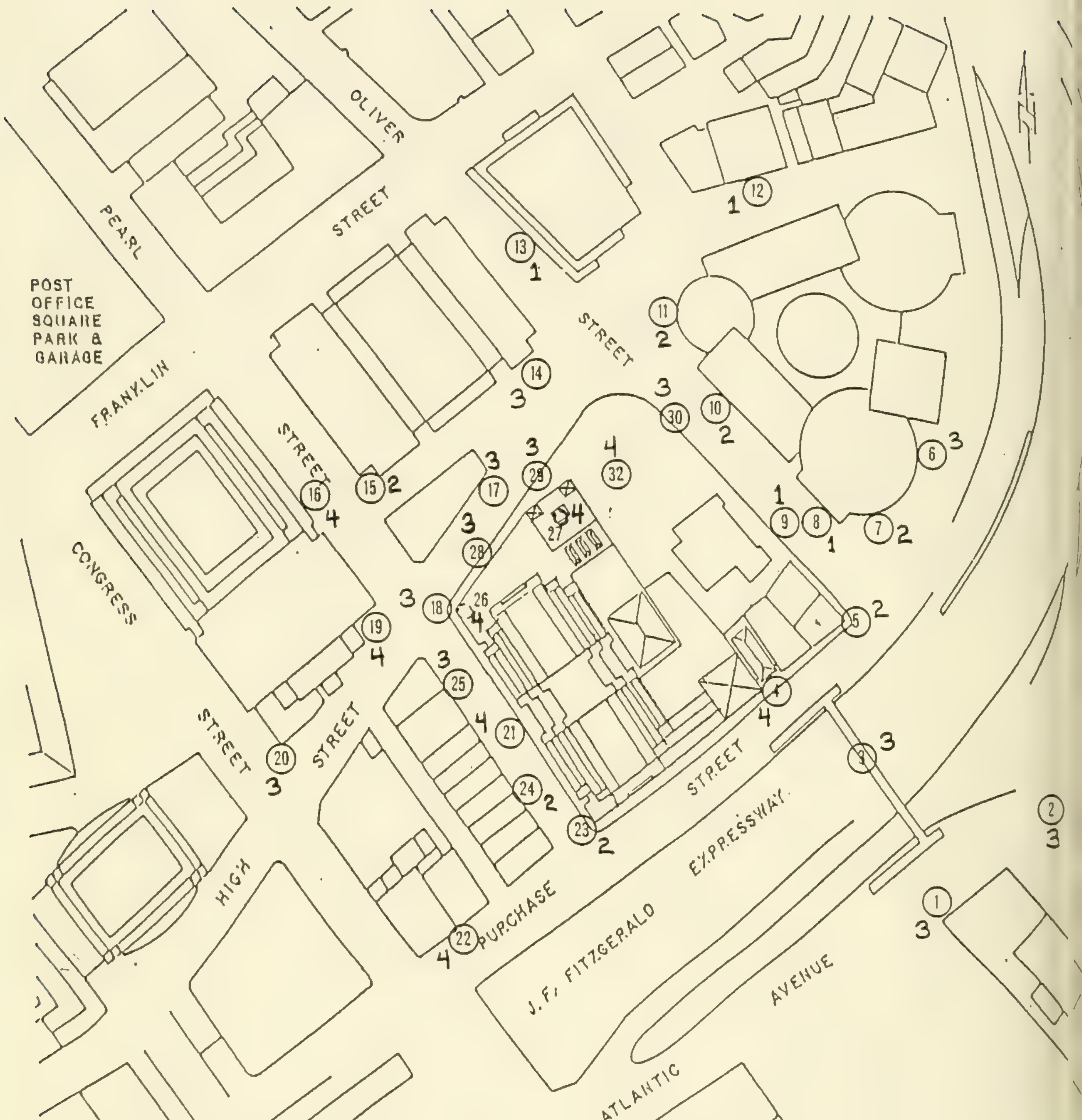


FIGURE 6.2-14b STORM EVENT CLASSIFICATION OF THE RESULTS BY ACTIVITY WITH THE 30 STORY BUILDING
(1 = 25-31 mph; 2 = 20-24 mph; 3 = 15-19 mph, 4 = 10-14 mph; 1 occassion per month)

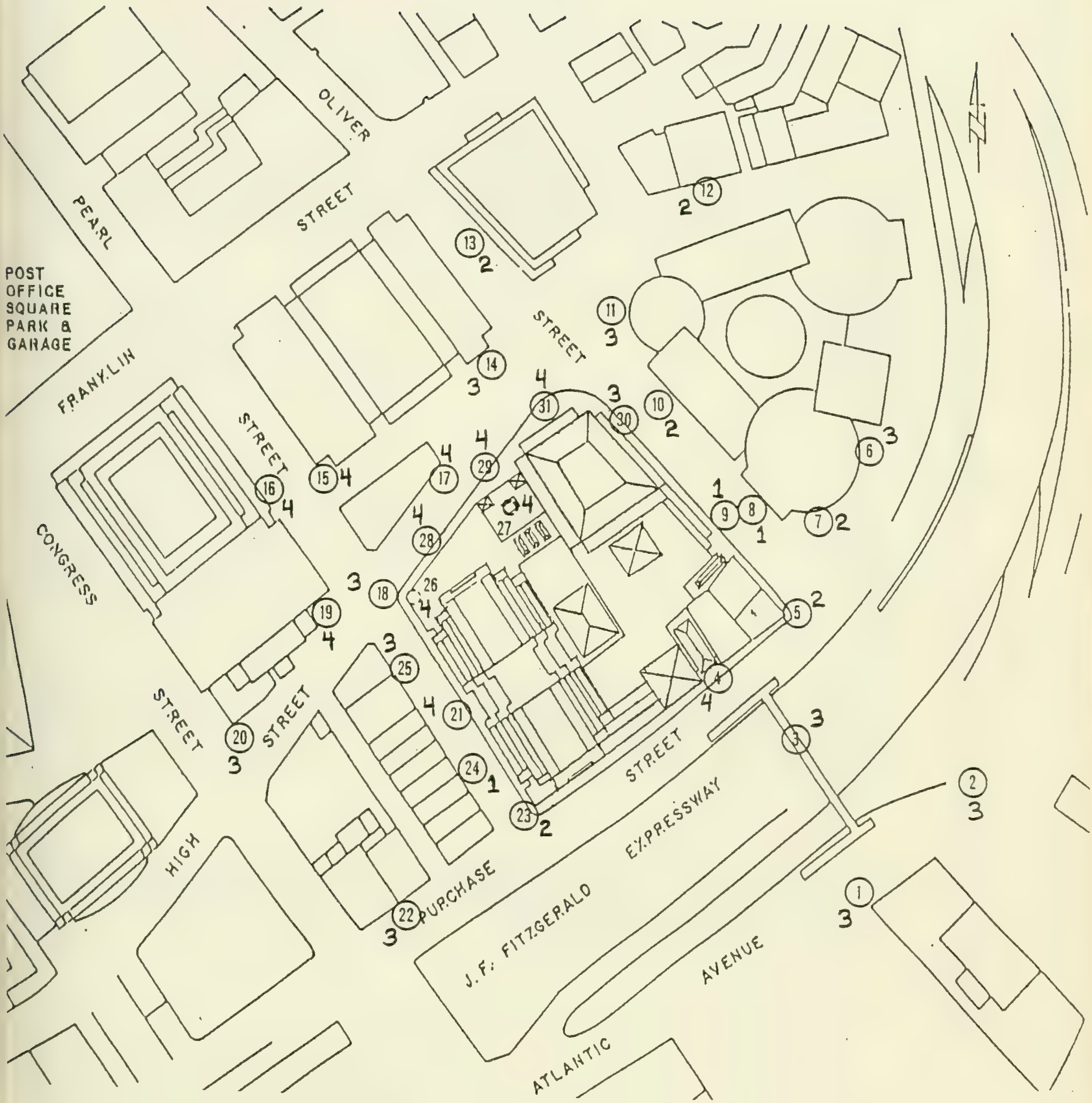


FIGURE 6.2-14c STORM EVENT CLASSIFICATION OF THE RESULTS BY ACTIVITY NUMBER WITH THE 30 AND 21 STORY BUILDINGS
(1 = 25-31 mph; 2 = 20-24 mph; 3 = 15-19 mph, 4 = 10-14 mph; 1 occassion per month)

TABLE 6.2-5

WIND SPEEDS (MPH) EXCEEDED 1% OF THE TIME ON AN ANNUAL BASIS

				Ratio of Results		
Probe	Current Site	30 Storey Building	30 Storey and 21 Storey Bldgs.	30 Storey Bldg.* / Current Site	30 Storey and* 21 Storey Bldgs. / Current Site	30 Storey and* 21 Storey Bldgs. / 30 Storey Bldg.
1		11.3 (18.2)	11.9 (19.1)			1.05 (1.05)
2		19.0 (24.1)	18.9 (23.9)			0.99 (0.99)
4		12.3 (18.3)	12.6 (18.0)			1.02 (0.98)
5		16.9 (22.9)	17.0 (23.0)			1.01 (1.00)
6		13.0 (18.4)	13.1 (18.8)			1.01 (1.02)
7		19.0 (24.1)	17.0 (22.1)			0.89 (0.92)
8		25.5 (29.9)	21.4 (26.8)			0.84 (0.90)
9		24.8 (29.9)	22.5 (27.7)			0.91 (0.93)
10		17.2 (24.0)	21.0 (26.2)			1.22 (1.09)
11		17.8 (24.2)	17.3 (23.8)			0.97 (0.98)
12		19.0 (24.8)	19.2 (25.0)			1.01 (1.01)
13		18.2 (26.1)	17.7 (26.0)			0.97 (1.00)
14		11.3 (17.2)	12.2 (18.3)			1.08 (1.06)
17		12.1 (18.8)	11.7 (17.9)			0.97 (0.95)
18		14.1 (19.9)	14.7 (19.9)			1.04 (1.00)
19		9.3 (14.4)	11.1 (16.1)			1.19 (1.12)
20	14.4 (21.7)	15.8 (22.5)	14.9 (21.3)	0.98 (0.96)	0.92 (0.91)	0.94 (0.95)
21	13.0 (17.1)	9.5 (15.2)	9.6 (15.4)	0.73 (0.87)	0.73 (0.89)	1.01 (1.01)
23	10.9 (15.2)	16.8 (20.6)	17.1 (20.5)	1.54 (1.33)	1.57 (1.32)	1.02 (1.00)
24	12.9 (17.6)	19.1 (23.1)	19.7 (23.3)	1.47 (1.30)	1.52 (1.31)	1.03 (1.01)
25	13.7 (18.3)	14.6 (20.2)	15.8 (21.5)	1.05 (1.09)	1.34 (1.16)	1.08 (1.06)
26	10.1 (15.2)	12.1 (16.8)	12.0 (16.5)	1.14 (1.07)	1.13 (1.05)	0.99 (0.98)
28	12.1 (17.8)	11.8 (17.1)	9.8 (14.7)	0.89 (0.89)	0.74 (0.77)	0.83 (0.86)
29	12.1 (18.5)	9.6 (15.5)	10.9 (16.4)	0.72 (0.78)	0.82 (0.82)	1.14 (1.06)
30	16.0 (23.2)	14.2 (21.2)	15.7 (21.9)	0.83 (0.87)	0.92 (0.90)	1.11 (1.03)
31	12.8 (19.3)	12.7 (19.2)	10.6 (16.2)	0.92 (0.95)	0.77 (0.80)	0.83 (0.84)
36	14.2 (21.4)	14.1 (21.4)	10.0 (15.5)	0.88 (0.91)	0.62 (0.66)	0.71 (0.72)
37	15.4 (21.7)	13.4 (19.6)	15.3 (20.9)	0.84 (0.88)	0.96 (0.94)	1.14 (1.07)
38	19.7 (25.1)	21.0 (25.7)	21.2 (25.7)	1.06 (1.02)	1.08 (1.02)	1.01 (1.00)
39	22.5 (28.8)	19.5 (27.0)	20.3 (26.3)	0.87 (0.94)	0.90 (0.91)	1.04 (0.97)
40	21.8 (26.9)	22.7 (27.1)	19.4 (23.9)	1.04 (1.00)	0.89 (0.89)	0.85 (0.88)
41	11.3 (14.9)	9.7 (14.5)	10.1 (15.0)	0.86 (0.96)	0.89 (0.99)	1.04 (1.03)

Typical Open Country 26.6 (34.6)

TABLE 6.2.6

NUMBER OF LOCATIONS IN EACH OF MELBOURNE'S CRITERIA CATEGORIES

Melbourne Criteria Category	Before* Development	30-Storey** Building	30-Storey and** 21-Storey Buildings
Unacceptable Speed ≥ 27 mph	0	0	0
Uncomfortable for walking 27 mph > speed ≥ 19 mph	7 (22%)	9 (28%)	8 (25%)
Comfortable for walking 19 mph > speed ≥ 15 mph	10 (31%)	6 (19%)	9 (28%)
Stationary short exposure 15 mph > speed ≥ 12 mph	10 (31%)	10 (31%)	6 (19%)
Stationary long exposure 12 mph > speed	5 (16%)	7 (22%)	9 (28%)
Total Number of Locations	32 (100%)	32 (100%)	32 (100%)

* Data taken from both quantitative studies

** Only data from second quantitative study used.

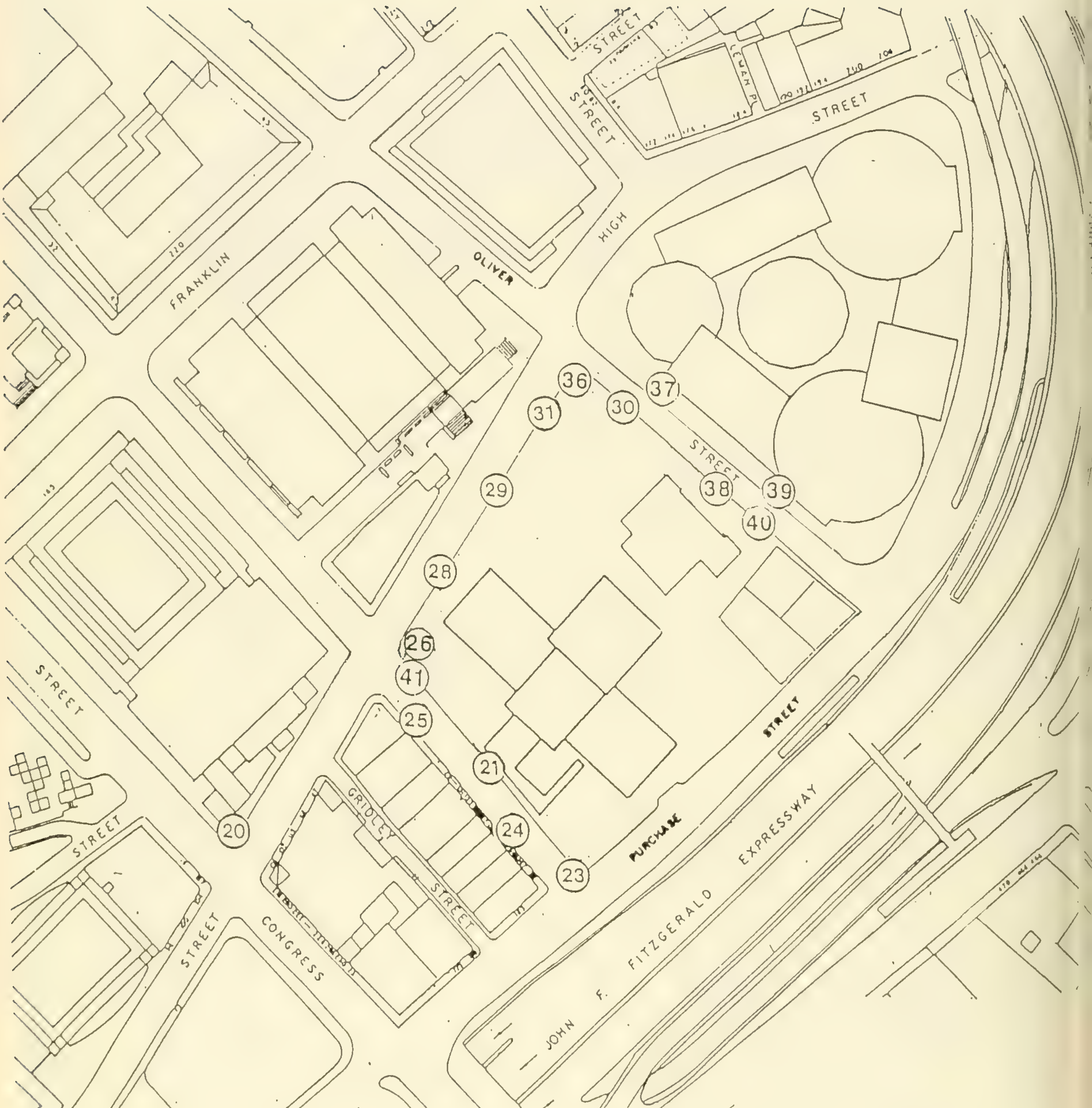


FIG 6.2 - 15 DIAGRAM SHOWING THE CURRENT SITE CONFIGURATION AND WIND SPEED MEASUREMENT LOCATIONS

TABLE 6.2-7

WIND SPEEDS EXCEEDED 1% OF THE TIME DURING VARIOUS SEASONS AS RATIOS OF THE SPEED EXCEEDED 1% OF THE TIME ANNUALLY

	PRESENT SITE				30 - STOREY BUILDING				30-STOREY AND 21-STOREY BUILDINGS			
Probe	Spring	Summer	Autumn	Winter	Spring	Summer	Autumn	Winter	Spring	Summer	Autumn	Winter
1					1.05(1.02)	0.76(0.80)	1.00(0.98)	1.05(1.05)	1.06(1.02)	0.76(0.80)	1.00(0.98)	1.04(1.0
2					1.10(1.09)	0.75(0.75)	0.99(0.99)	0.98(0.99)	1.10(1.09)	0.75(0.75)	0.99(0.99)	0.98(0.9
4					1.07(1.05)	0.74(0.76)	1.00(0.99)	1.01(1.02)	1.10(1.07)	0.73(0.75)	1.01(1.00)	0.99(1.0
5					1.10(1.09)	0.74(0.74)	1.00(0.99)	0.99(0.99)	1.09(1.09)	0.74(0.74)	1.00(1.00)	1.00(1.0
6					1.07(1.05)	0.76(0.77)	1.00(0.99)	1.01(1.02)	1.06(1.04)	0.77(0.79)	0.99(0.99)	1.02(1.0
7					1.09(1.09)	0.76(0.75)	0.98(0.99)	0.98(0.99)	1.10(1.10)	0.76(0.75)	0.98(0.99)	0.97(0.9
8					1.08(1.08)	0.77(0.76)	0.97(0.98)	0.98(0.99)	1.09(1.08)	0.77(0.76)	0.98(0.98)	0.98(0.9
9					1.08(1.08)	0.77(0.76)	0.98(0.98)	0.98(0.99)	1.08(1.08)	0.77(0.76)	0.98(0.98)	0.99(1.0
10					1.07(1.07)	0.77(0.76)	0.98(0.98)	1.00(1.01)	1.09(1.08)	0.79(0.77)	0.97(0.97)	0.98(0.9
11					1.05(1.04)	0.75(0.75)	1.00(1.00)	1.06(1.06)	1.06(1.04)	0.73(0.74)	1.01(1.00)	1.05(1.0
12					1.10(1.09)	0.84(0.82)	0.96(0.96)	0.97(0.99)	1.11(1.09)	0.84(0.82)	0.96(0.96)	0.97(0.9
13					1.03(1.03)	0.76(0.76)	0.94(0.94)	1.07(1.07)	1.03(1.03)	0.76(0.76)	0.94(0.94)	1.08(1.0
14					1.07(1.06)	0.78(0.77)	0.98(0.98)	1.00(1.01)	1.05(1.05)	0.74(0.75)	0.99(0.98)	1.04(1.0
17					1.07(1.05)	0.80(0.80)	0.96(0.96)	1.02(1.02)	1.03(1.02)	0.81(0.82)	0.99(0.98)	1.04(1.0
18					1.02(1.03)	0.80(0.80)	0.98(0.97)	1.03(1.03)	1.04(1.03)	0.82(0.82)	0.97(0.97)	1.02(1.0
19					1.09(1.04)	0.88(0.85)	0.95(0.96)	0.96(0.99)	1.11(1.08)	0.87(0.85)	0.94(0.95)	0.94(0.9
20	1.05(1.03)	0.77(0.78)	0.96(0.96)	1.04(1.04)	1.04(1.03)	0.75(0.77)	0.97(0.96)	1.05(1.05)	1.03(1.02)	0.76(0.77)	0.96(0.95)	1.06(1.0
21	1.09(1.07)	0.83(0.80)	0.96(0.97)	0.97(0.99)	1.03(1.03)	0.79(0.79)	0.97(0.97)	1.02(1.03)	1.04(1.04)	0.79(0.79)	0.97(0.97)	1.02(1.0
23	1.08(1.08)	0.77(0.75)	0.98(0.99)	0.99(1.00)	1.08(1.08)	0.79(0.78)	0.97(0.97)	0.98(0.99)	1.09(1.08)	0.80(0.79)	0.96(0.97)	0.97(0.9
24	1.09(1.08)	0.81(0.79)	0.97(0.97)	0.98(0.99)	1.10(1.09)	0.82(0.81)	0.95(0.96)	0.96(0.97)	1.10(1.09)	0.82(0.81)	0.95(0.96)	0.96(0.9
25	1.08(1.06)	0.81(0.78)	0.97(0.98)	0.99(1.01)	1.05(1.04)	0.77(0.78)	0.99(0.98)	1.04(1.03)	1.06(1.06)	0.79(0.80)	0.98(0.97)	1.02(1.0
26	1.08(1.05)	0.82(0.81)	0.97(0.97)	1.00(1.02)	1.02(1.01)	0.79(0.81)	0.98(0.98)	1.05(1.04)	1.00(1.00)	0.81(0.83)	0.97(0.97)	1.05(1.0
28	1.07(1.04)	0.83(0.80)	0.95(0.95)	1.01(1.04)	1.13(1.11)	0.83(0.82)	0.96(0.97)	0.96(0.98)	1.04(1.04)	0.75(0.77)	0.99(0.98)	1.06(1.0
29	1.05(1.04)	0.83(0.80)	0.96(0.96)	1.02(1.03)	1.06(1.04)	0.78(0.78)	0.97(0.97)	1.02(1.02)	1.06(1.03)	0.75(0.79)	1.00(0.99)	1.04(1.0
30	1.05(1.04)	0.76(0.76)	0.99(0.98)	1.03(1.03)	1.04(1.03)	0.79(0.78)	0.98(0.97)	1.05(1.06)	1.08(1.06)	0.77(0.76)	0.97(0.97)	0.99(1.0
31	1.06(1.05)	0.76(0.76)	0.99(0.98)	1.04(1.05)	1.05(1.04)	0.76(0.76)	0.99(0.98)	1.03(1.05)	1.06(1.04)	0.76(0.76)	1.00(0.99)	1.05(1.0
36	1.04(1.02)	0.79(0.80)	0.98(0.97)	1.04(1.05)	1.04(1.03)	0.76(0.77)	0.98(0.96)	1.05(1.06)	1.06(1.04)	0.75(0.76)	0.98(0.97)	1.04(1.0
37	1.07(1.07)	0.78(0.77)	0.97(0.98)	0.99(1.00)	1.07(1.06)	0.77(0.77)	0.98(0.98)	1.00(1.01)	1.08(1.07)	0.79(0.78)	0.97(0.97)	0.98(1.0
38	1.08(1.08)	0.77(0.75)	0.98(0.99)	0.99(0.99)	1.08(1.08)	0.76(0.75)	0.98(0.99)	0.99(0.99)	1.08(1.08)	0.77(0.76)	0.98(0.98)	0.98(0.9
39	1.09(1.09)	0.76(0.76)	0.98(0.98)	0.98(0.98)	1.10(1.09)	0.76(0.76)	0.98(0.98)	0.98(0.98)	1.09(1.08)	0.78(0.77)	0.97(0.98)	0.98(0.9
40	1.08(1.08)	0.76(0.75)	0.98(0.99)	0.99(0.99)	1.08(1.08)	0.76(0.75)	0.98(0.99)	0.99(0.99)	1.08(1.08)	0.76(0.75)	0.98(0.99)	0.99(1.0
41	1.09(1.08)	0.84(0.82)	0.96(0.97)	0.97(0.99)	1.02(1.01)	0.86(0.85)	0.98(0.98)	1.02(1.02)	1.02(1.02)	0.85(0.84)	0.98(0.98)	1.02(1.0
Average	1.07(1.06)	0.79(0.78)	0.97(0.97)	1.00(1.01)	1.07(1.06)	0.78(0.78)	0.98(0.98)	1.01(1.01)	1.07(1.06)	0.78(0.78)	0.98(0.98)	1.01(1.0

Legend: Mean (Gust)

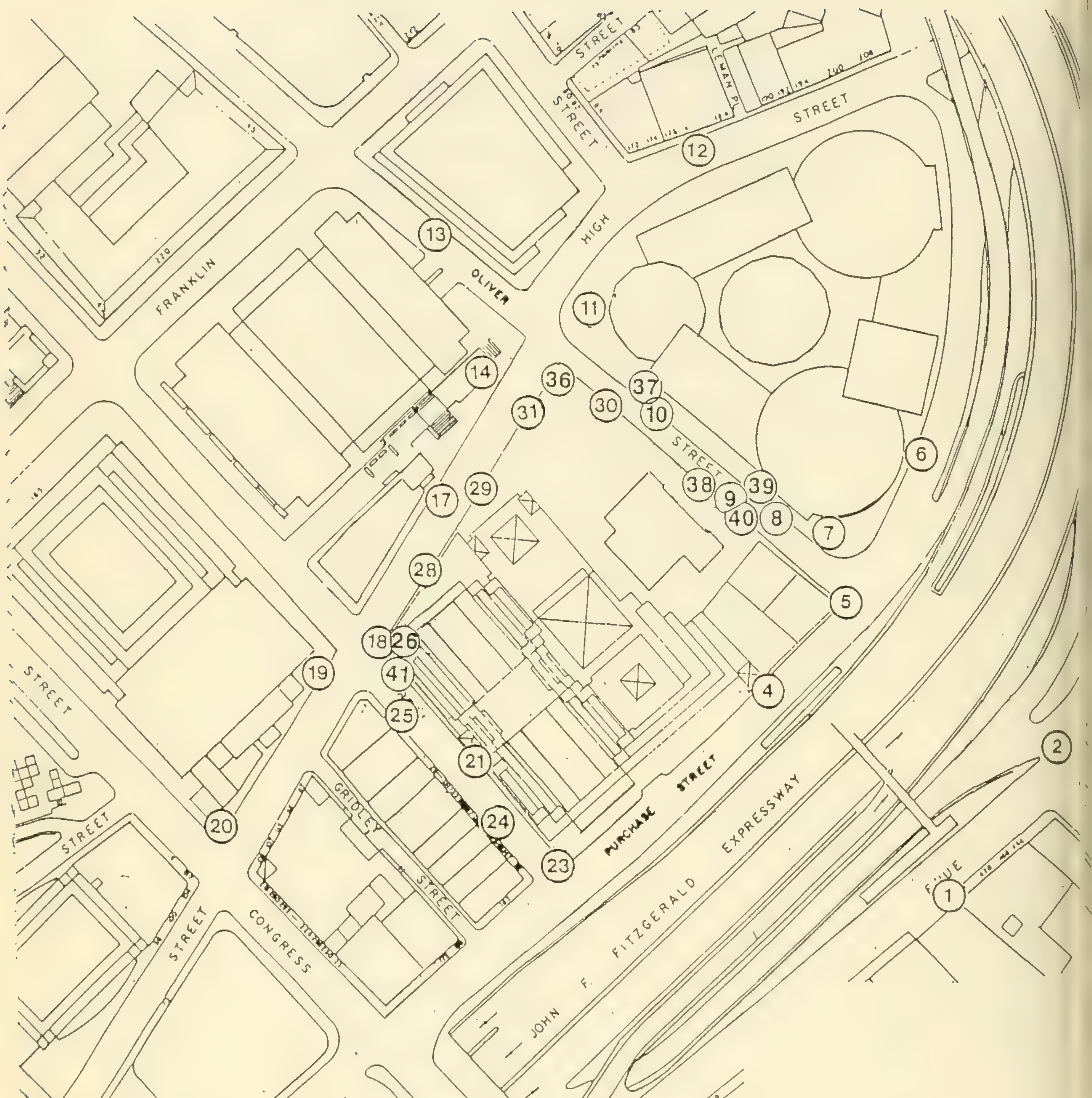


FIG 6.2 - 16 DIAGRAM SHOWING THE 30-STOREY BUILDING ALONE CONFIGURATION AND WIND SPEED MEASUREMENT LOCATIONS

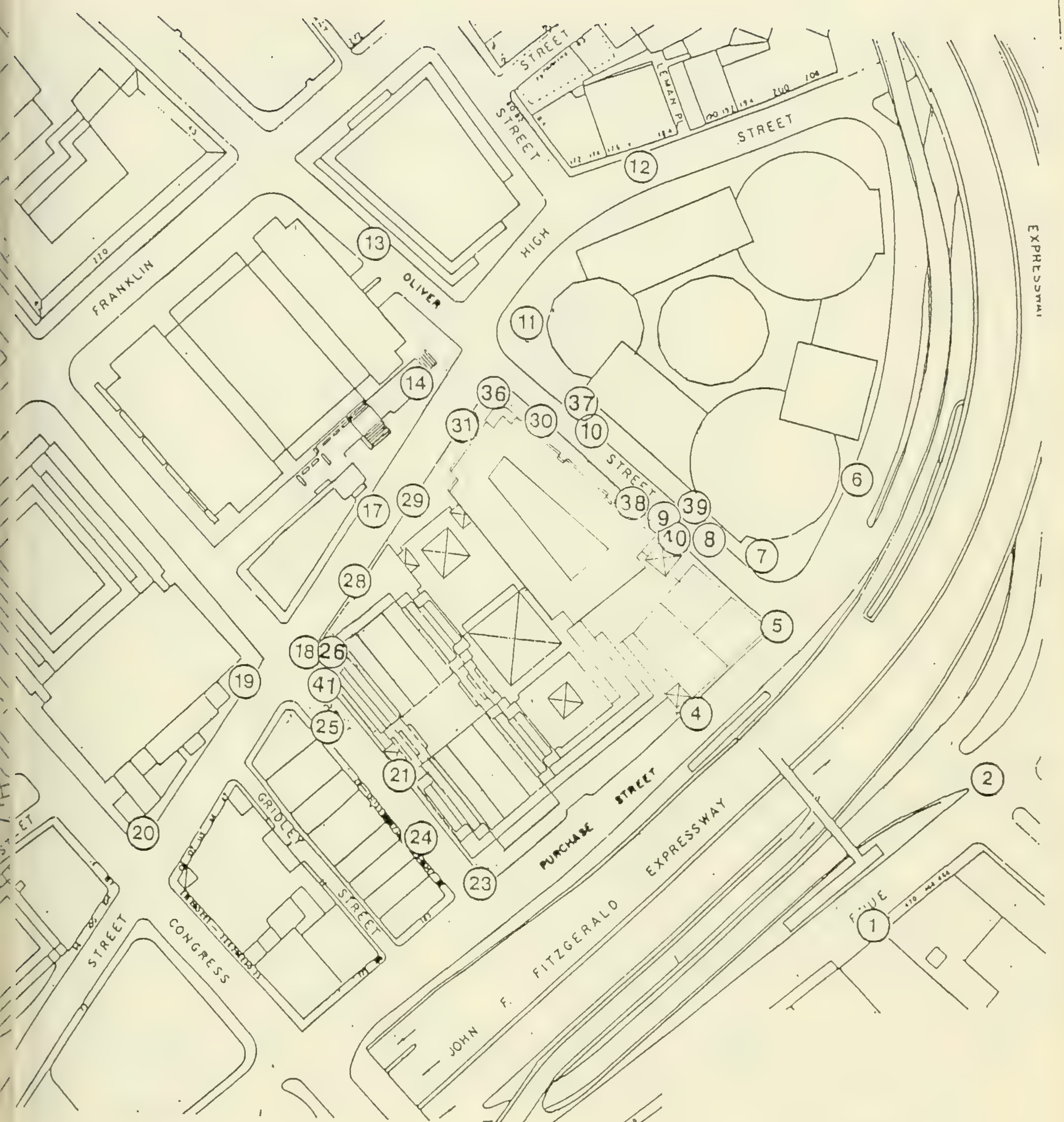


FIG 6.2 - 17 DIAGRAM SHOWING THE 30-STOREY AND 21-STOREY BUILDINGS CONFIGURATION (FULL DEVELOPMENT) AND WIND SPEED MEASUREMENT LOCATIONS

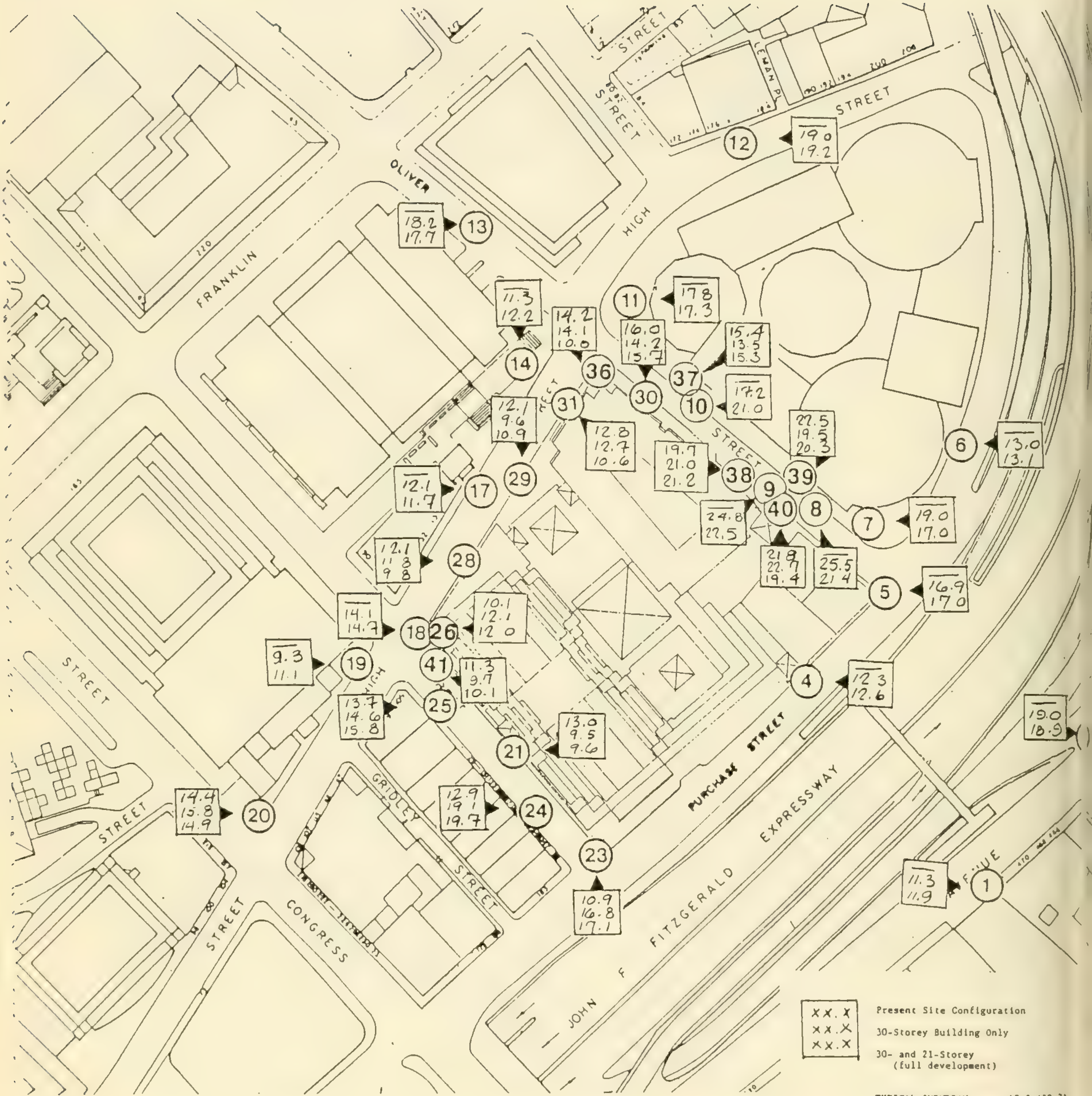


FIG 6.2 - 18 MEAN WIND SPEEDS EXPECTED TO BE EXCEEDED 1% OF THE TIME ON AN ANNUAL BASIS

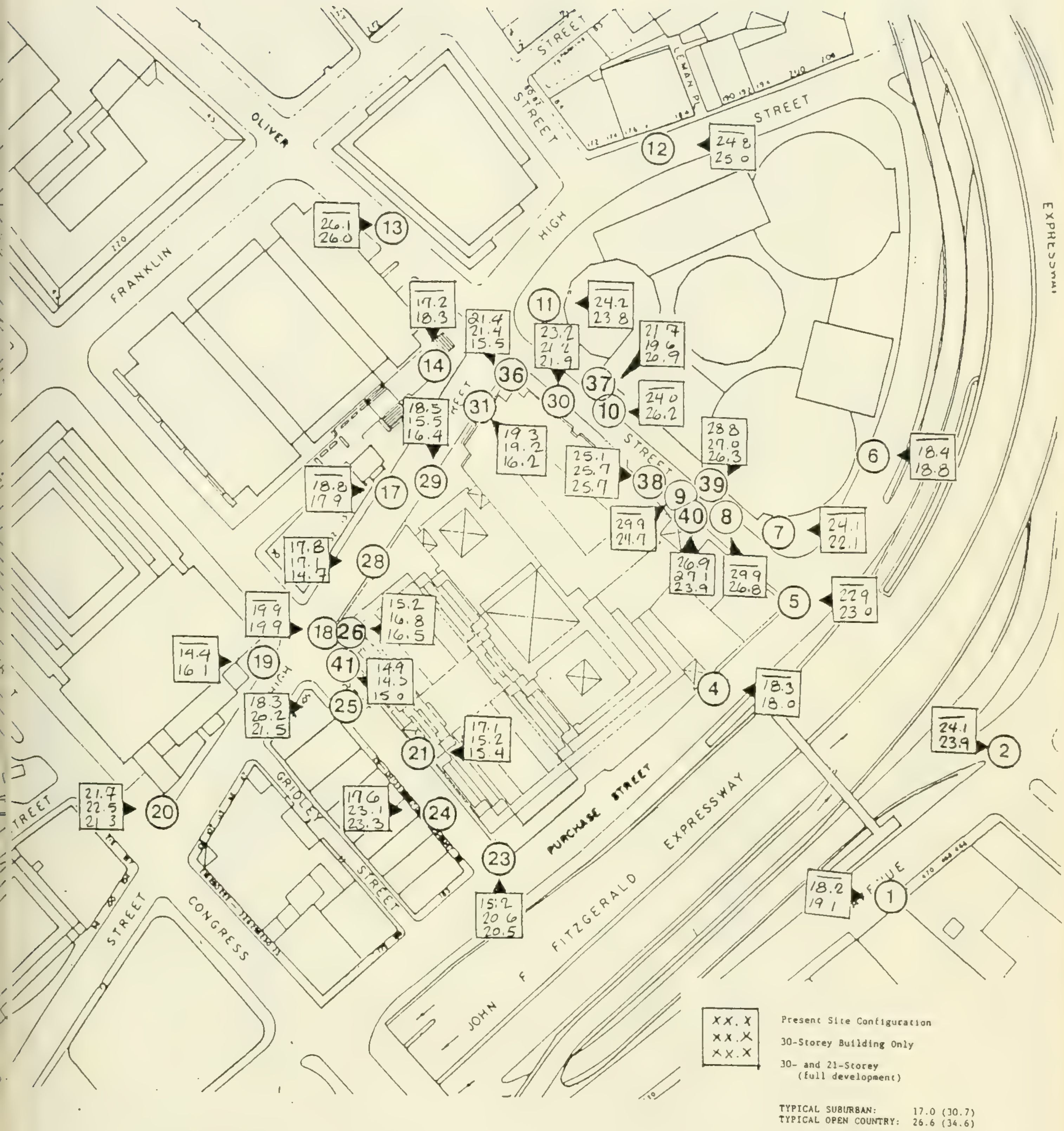
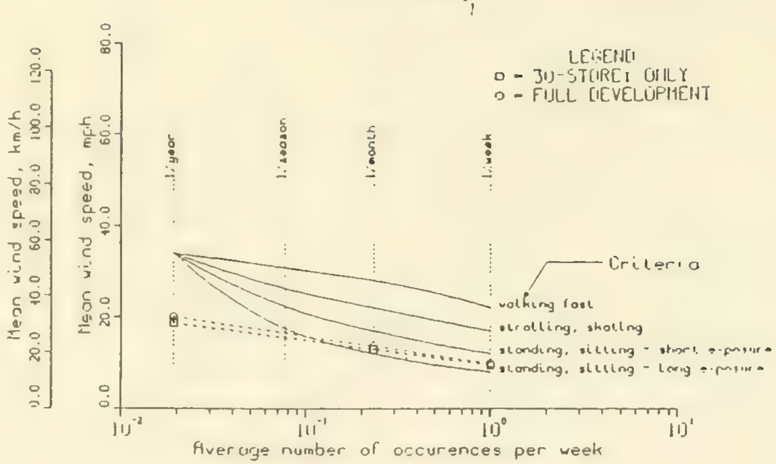
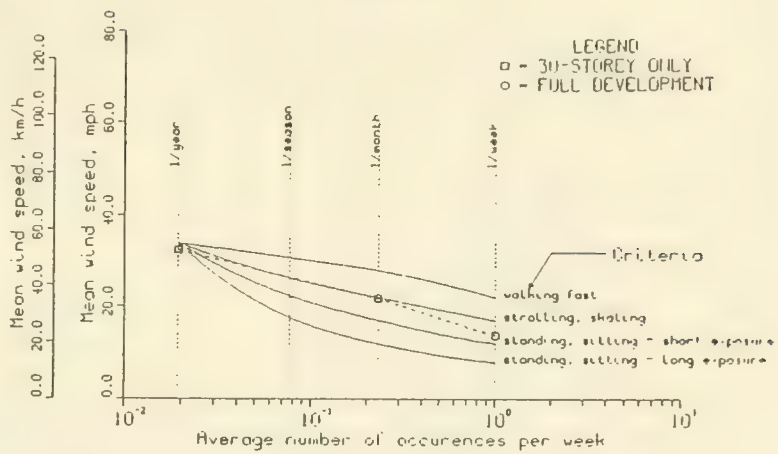


FIG 6.2 - 19 GUST WIND SPEEDS EXPECTED TO BE EXCEEDED 1% OF THE TIME ON AN ANNUAL BASIS

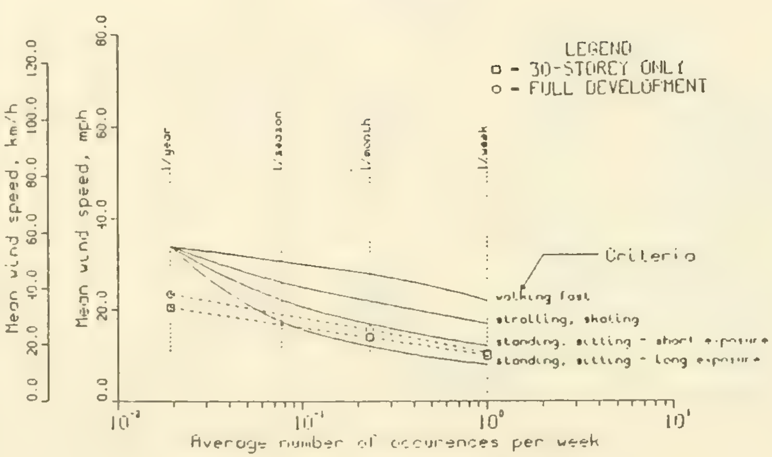
LOCATION 1



LOCATION 2



LOCATION 4



LOCATION 5

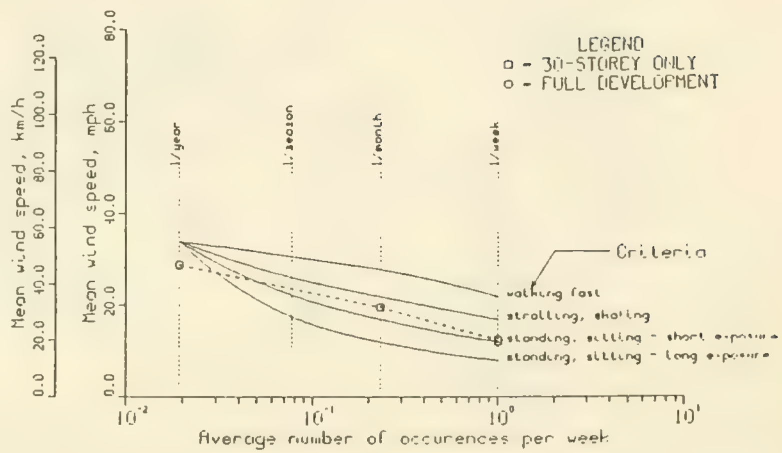


FIG 6.2 - 20 MEAN WIND SPEEDS EXCEEDED FOR VARIOUS ANNUAL FREQUENCIES OF OCCURRENCE

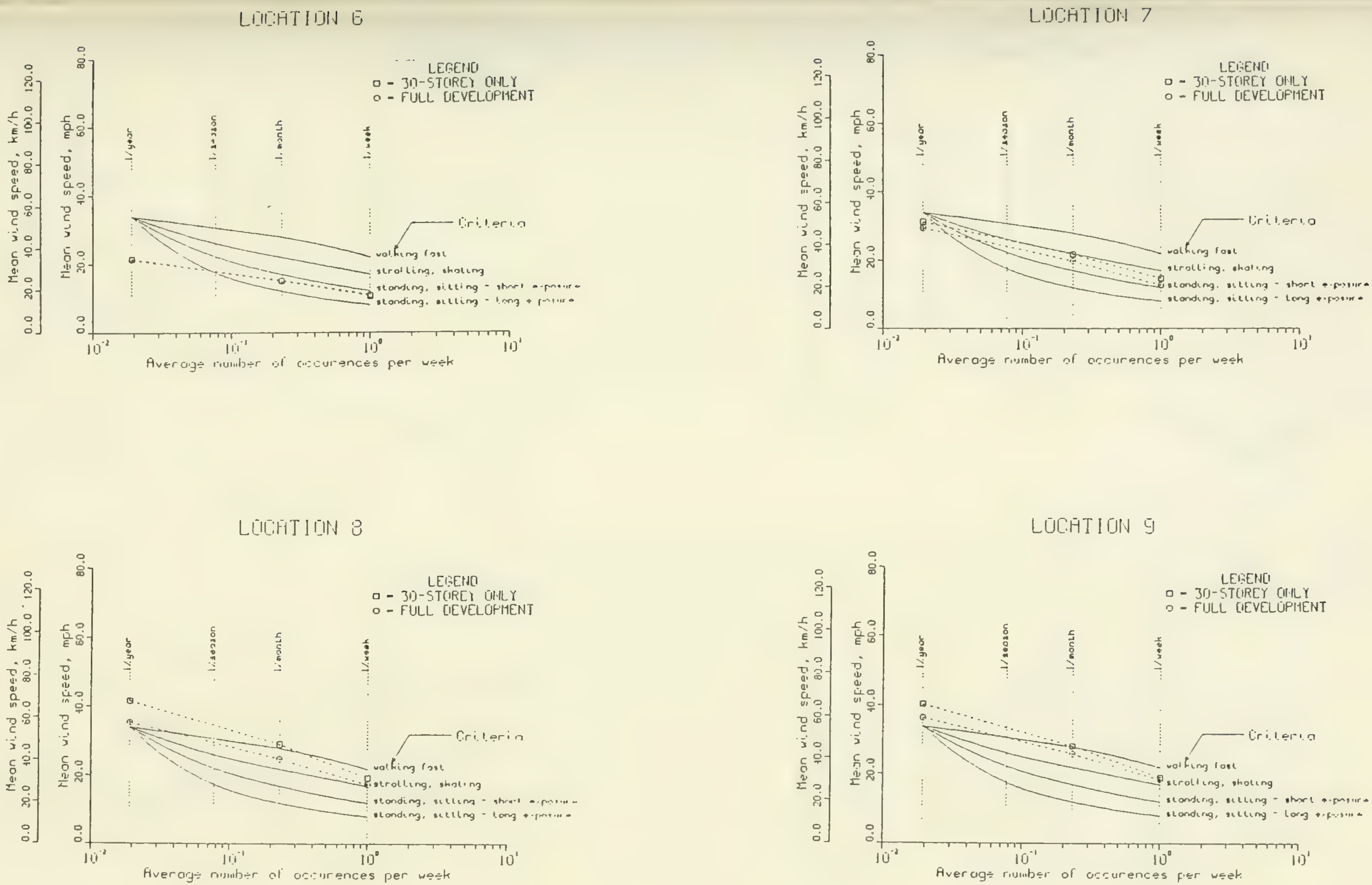


FIG 6.2 - 21 MEAN WIND SPEEDS EXCEEDED FOR VARIOUS ANNUAL FREQUENCIES OF OCCURRENCE

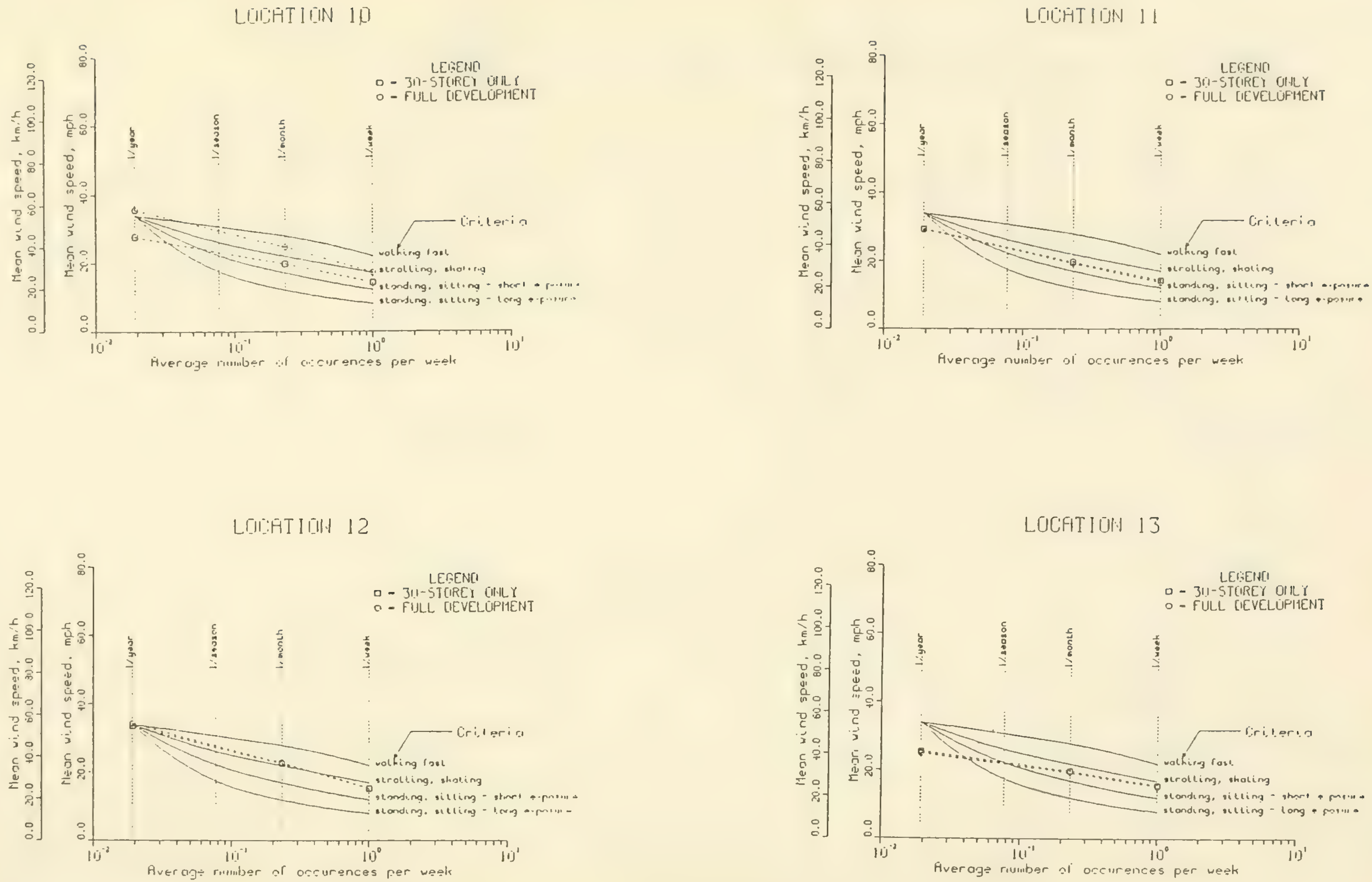


FIG 6.2 - 22 MEAN WIND SPEEDS EXCEEDED FOR VARIOUS ANNUAL FREQUENCIES OF OCCURRENCE

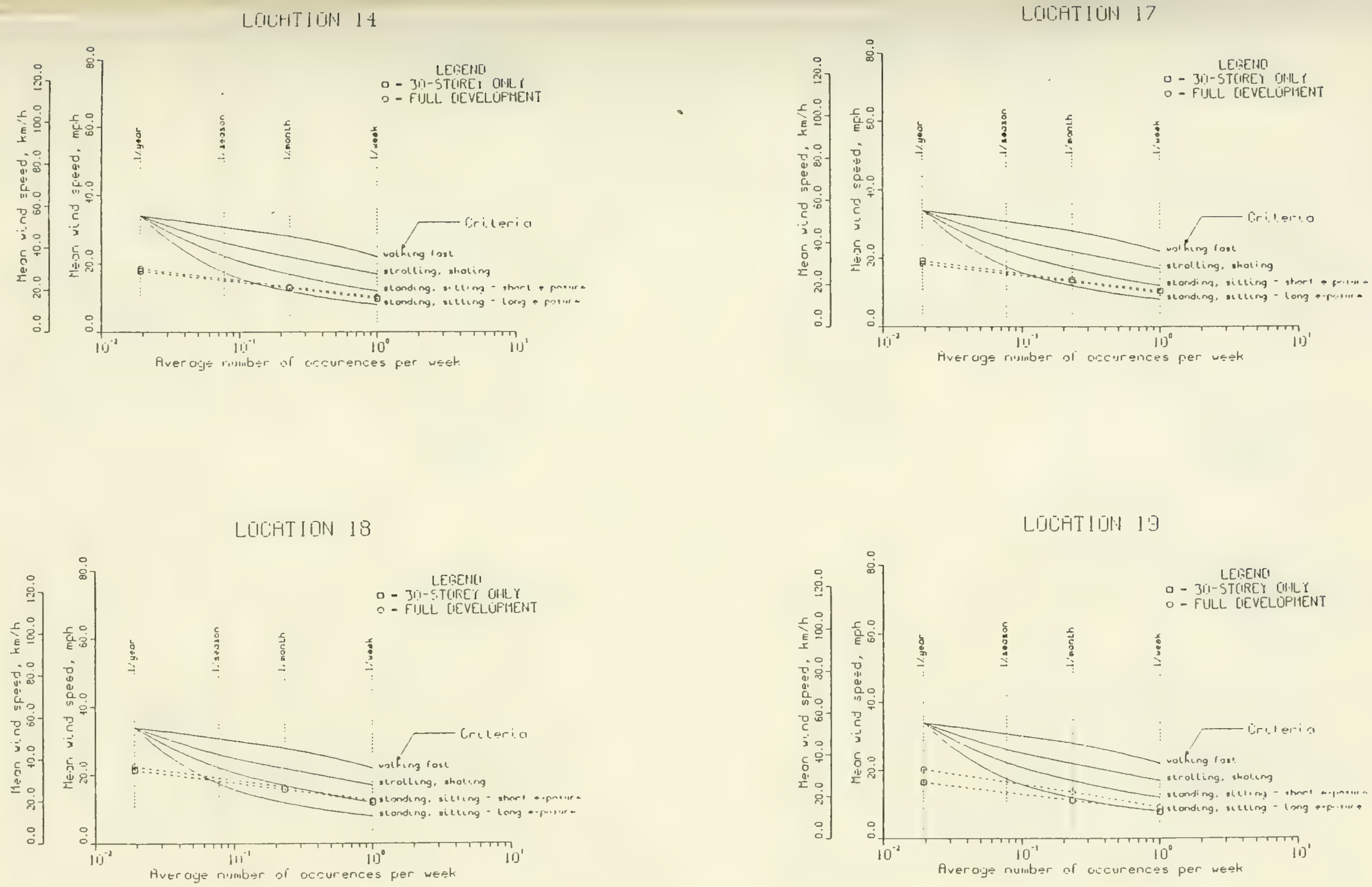


FIG 6.2 - 23 MEAN WIND SPEEDS EXCEEDED FOR VARIOUS ANNUAL FREQUENCIES OF OCCURRENCE

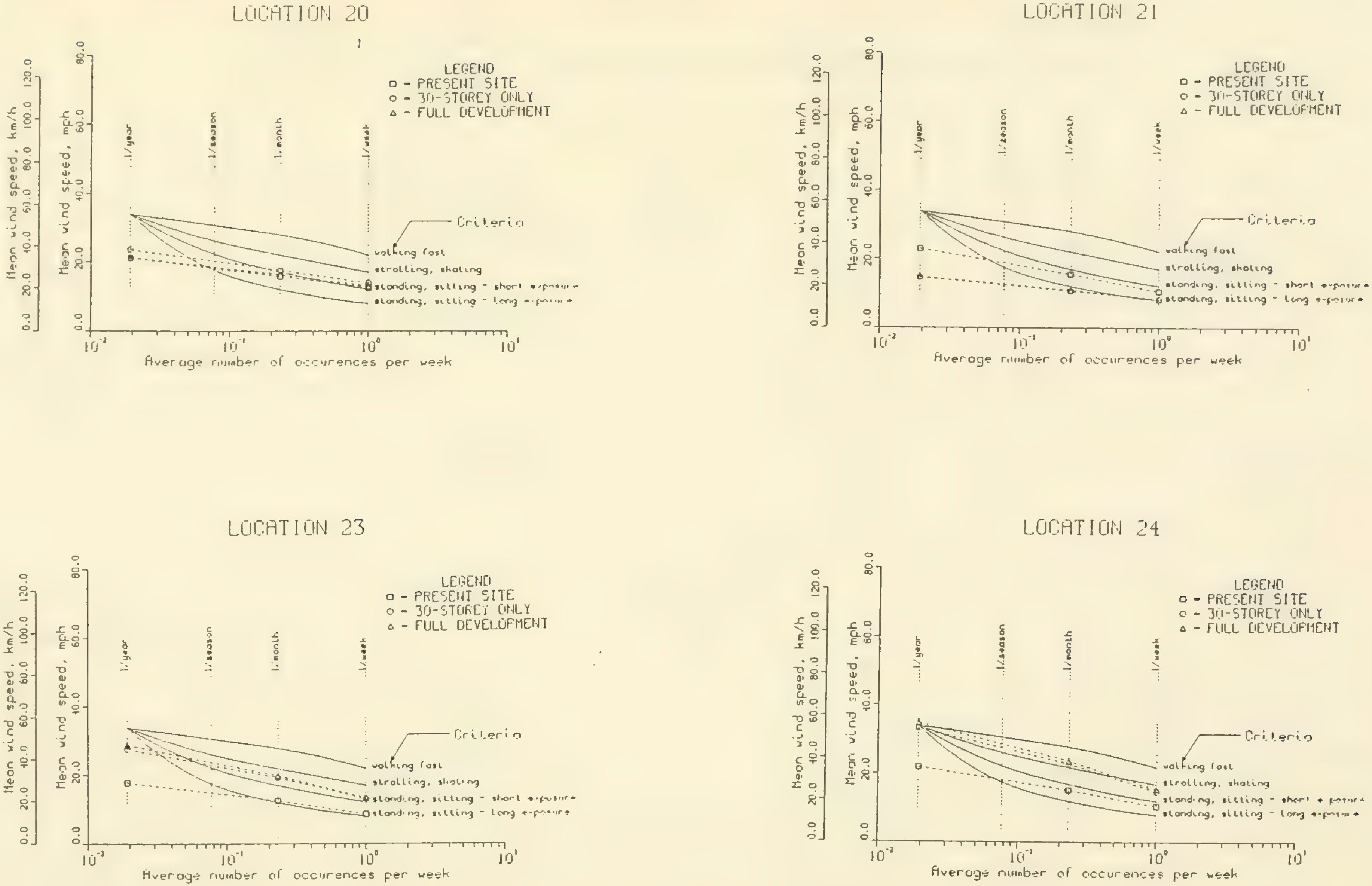
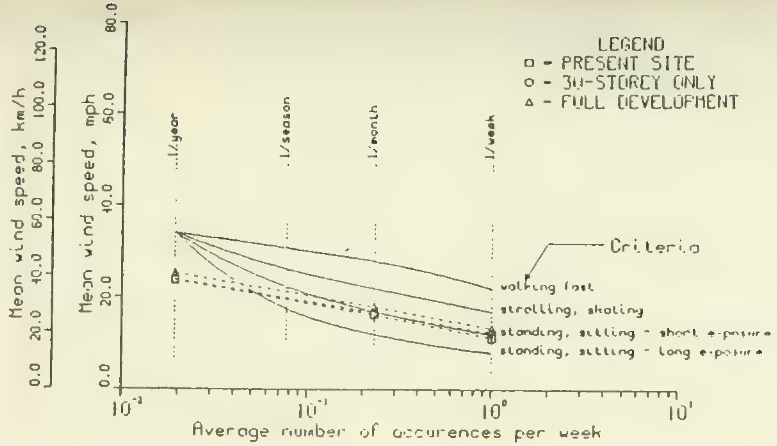
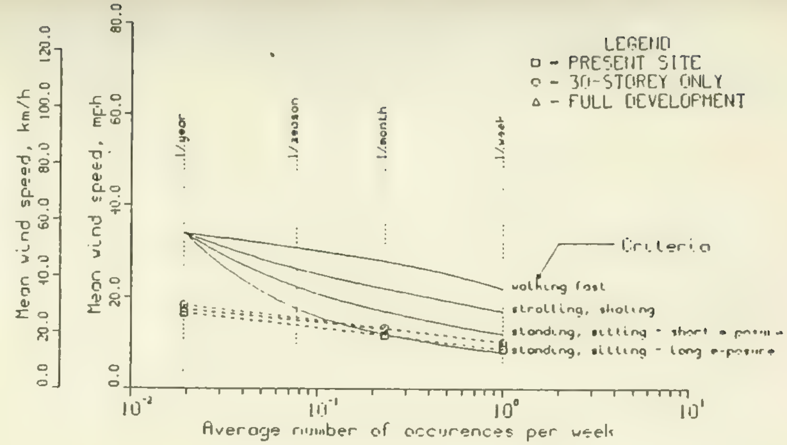
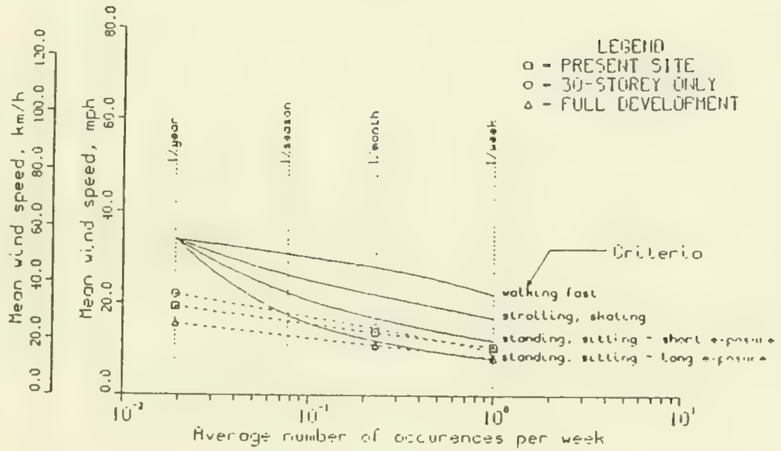


FIG 6.2 - 24 MEAN WIND SPEEDS EXCEEDED FOR VARIOUS ANNUAL FREQUENCIES OF OCCURRENCE





LOCATION 28



LOCATION 29

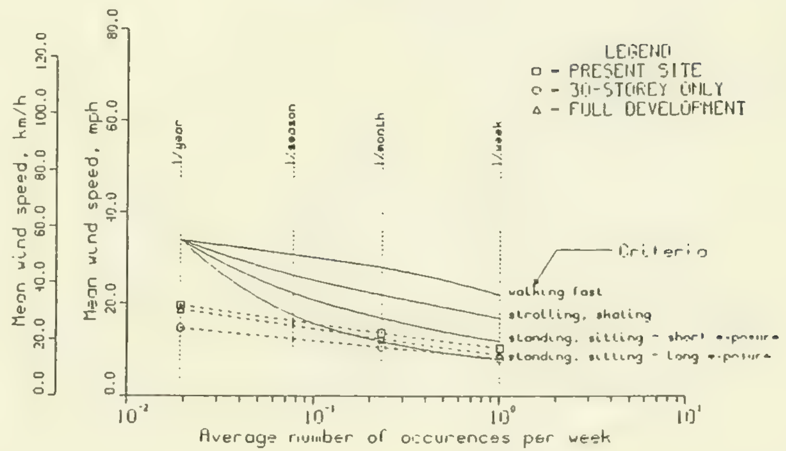


FIG 6.2 - 25 MEAN WIND SPEEDS EXCEEDED FOR VARIOUS ANNUAL FREQUENCIES OF OCCURRENCE

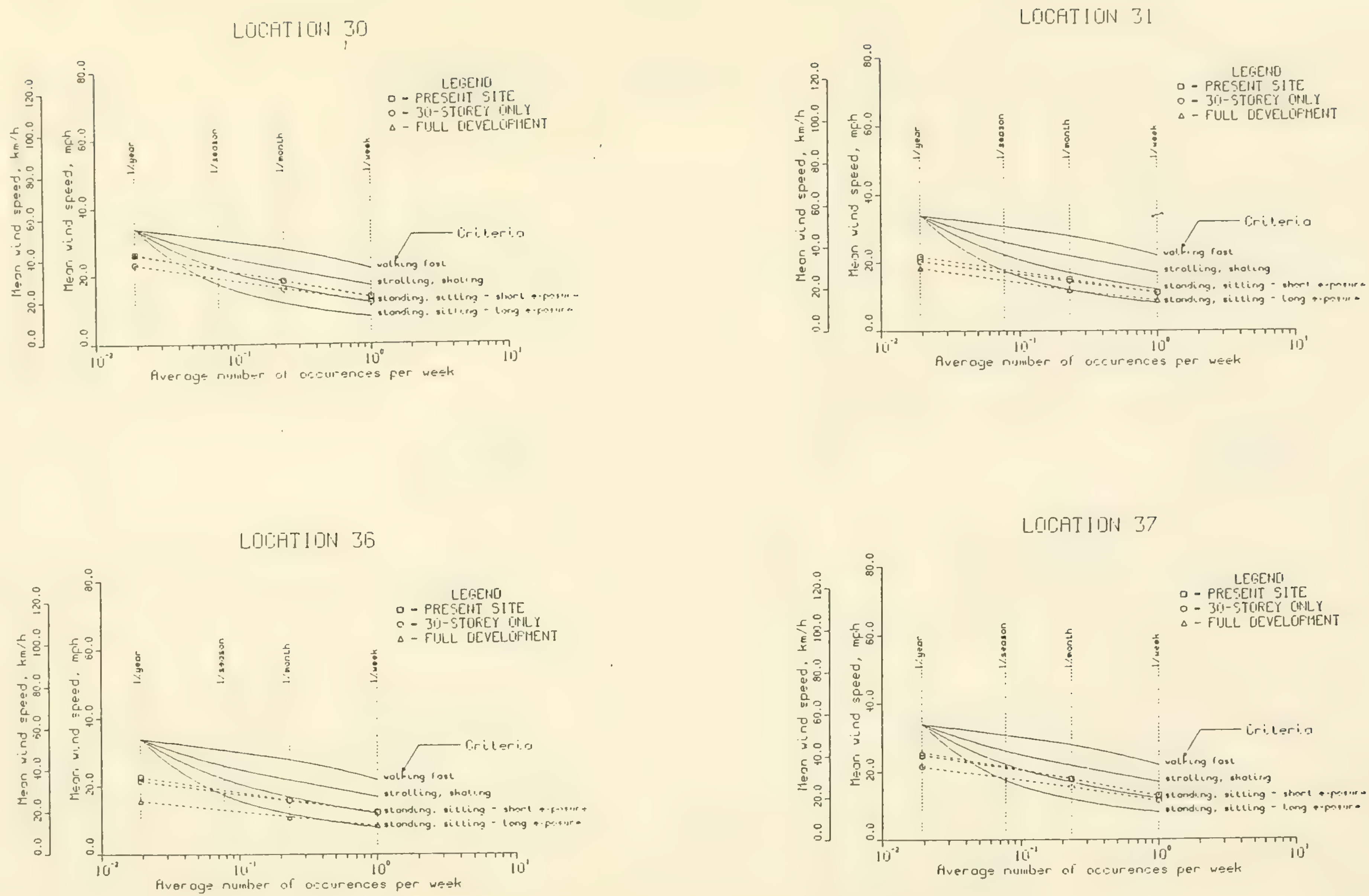
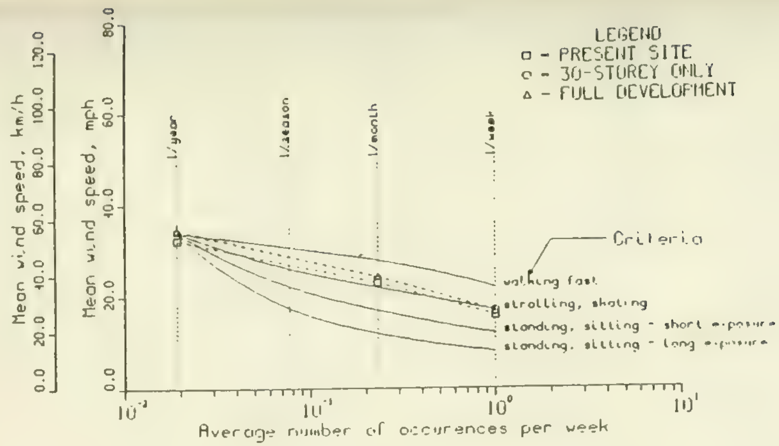
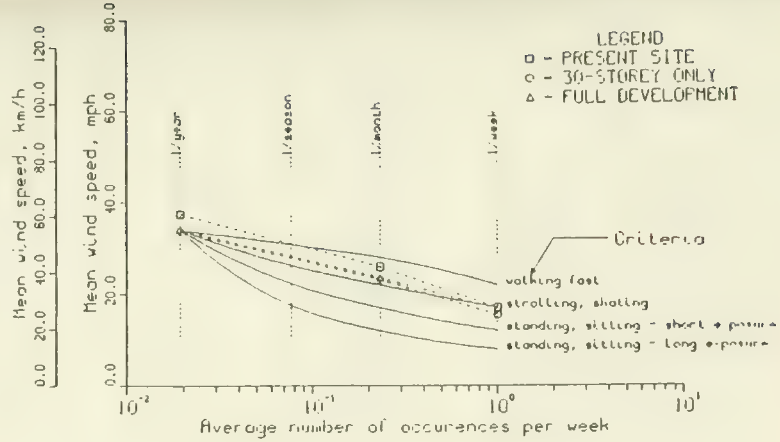


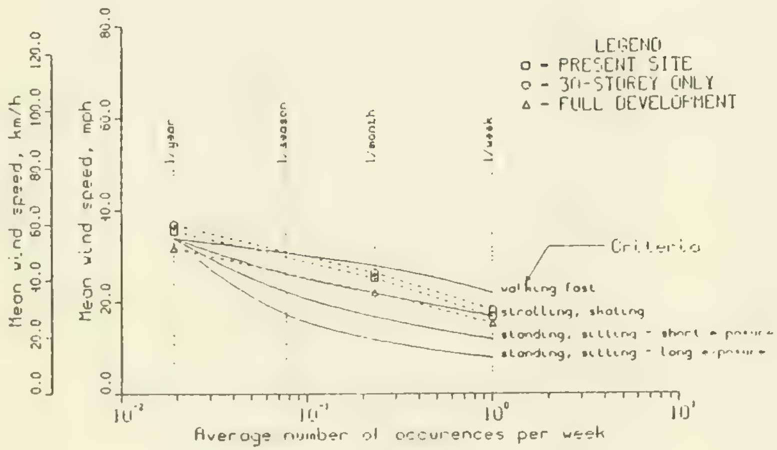
FIG 6.2 - 26 MEAN WIND SPEEDS EXCEEDED FOR VARIOUS ANNUAL FREQUENCIES OF OCCURRENCE





LOCATION 40

LOCATION 41



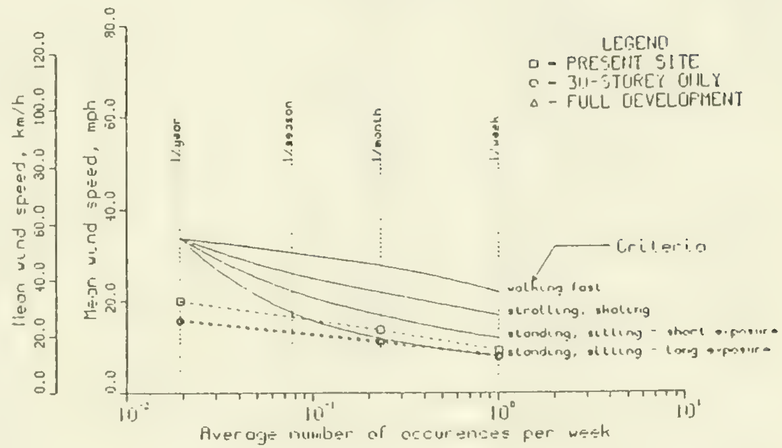


FIG 6.2 - 27 MEAN WIND SPEEDS EXCEEDED FOR VARIOUS ANNUAL FREQUENCIES OF OCCURRENCE

REFERENCES

1. Lythe, G.R. and Surry, D., "An Investigation of the Wind Environment for Various Massings of the Prospect Development, Boston: A Summary Report", The University of Western Ontario, Engineering Science Research Report, BLWT-SS20-1985.

2. Lythe, G.R. and Surry, D., "An Investigation of the Wind Environment Around the Prospect Development, Boston, Using a Sand Scour Technique: A Summary Report", The University of Western Ontario, Engineering Science Research Report, BLWT-SS20-1986.

3. Davenport, A.G., "An Approach to Human Comfort Criteria for Environmental Wind Conditions", Colloquium on Building Climatology, Stockholm, Sept. 1972.

4. Peterka, J.A. and Cermak, J.E., "Wind Tunnel Study of International Place Boston Pedestrian Wind Analysis", Fluid Dynamics and Diffusion Laboratory, Department of Civil Engineering, Colorado State University, Fort Collins, Colorado, CSU Project 2-95820, May 1984.

5. Isyumov, N. and Davenport, A.G., "The Ground Level Wind Environment in Built-Up Areas", Proc. of 4th Int. Conf. on Wind Effects on Buildings and Structures, London, England, Sept. 1975, Cambridge Univ. Press, 1977.

6. Isyumov, N., "Studies of the Pedestrian Level Wind Environment at the Boundary Layer Wind Tunnel Laboratory of the University of Western Ontario", Journ. Indust. Aerodynamics, Vol. 3, Nos. 2, 3, July 1978.

7. Journal of Industrial Aerodynamics, "The Wind Content of Built Environment", Special Issue, Vol. 3, Nos. 2, 3, July 1978.

8. Isyumov, N., "Wind Tunnel Methods for Evaluating Wind Effects on Buildings and Structures", Int. Symposium on Exp. Mech., Univ. of Waterloo, Waterloo, June 1972.

9. Davenport, A.G. and Isyumov, N., "The Application of the Boundary Layer Wind Tunnel to the Prediction of Wind Loading", Proc. Int. Seminar on Wind Effects on Building and Structures, Ottawa, 1967, Vol. 1.

10. Surry D. and Isyumov, N., "Model Studies of Wind Effects - A Perspective on the Problems of Experimental Technique and Instrumentation", I.C.I.A.S.F. - 75, Ottawa, Sept. 1975.

11. Davenport, A.G., "On Statistical Predictions of Structural Performance in the Wind Environment", ASCE Nat. Struct. Meeting, Baltimore, MD, April 1971.

12. Aynsley, R.M., Melbourne, W. and Vickery, B.J., "Architectural Aerodynamics, Applied Science Publishers Ltd., London, 1977.

13. "On Building Downtown: Design Guidelines for the Core Area", A Report to the City of Toronto Planning Board, prepared by the Design Guidelines Study Group of George Baird, Roger du Toit, Robert Hill, Bruce Buwabara, Alan Littlewood, Donald McKay, Stephen McLaughlin, Belinda Sugarman and John van Nostrand, with the assistance of A.G. Davenport, Second Edition, September 1974.

14. Lythe, G.R. and Surry, D., "An Investigation of the Wind Environment for Various Massings of the Prospect Development, Boston: A Summary Report", The University of Western Ontario, Engineering Science Research Report, BLWT-SS20-1985.

15. Lythe, G.R. and Surry, D., "An Investigation of the Wind Environment Around the Prospect Development, Boston, Using a Sand Scour Technique: A Summary Report", The University of Western Ontario, Engineering Science Research Report, BLWT-SS20-1986.

16. Lythe, G.R. and Surry, D., "A Study of the Impact of the Prospect Development, Boston, On the Pedestrian Level Wind Environment", The University of Western Ontario, Engineering Science Research Report, BLWT-SS23-1986.

6.3 SHADOW

This chapter presents the results of shadow diagrams that were compiled to depict new shadows associated with One Twenty Five High Street. Particular attention was given to plazas, sidewalks, and other public open space areas likely to be affected by the proposed new buildings' shadows. These include Post Office Square, Winthrop Square at the corner of Devonshire and Otis Streets, Daniel Webster Park public spaces and plazas around Fanueil Hall/Quincy Market, and City Hall Plaza. The Custom House District has also been considered as a shadow sensitive area.

Shadows for each season were studied as follows: summer solstice (June 22); vernal and autumnal equinox (March 21/ September 23); and winter solstice shadow (December 22). For each of these times of year, representative morning (9:00 AM), noon (12:00 PM), and afternoon (3:00 PM) shadow patterns were calculated. Additional shadow analyses were also conducted for 10:00 AM, 11:00 AM, 12:00 Noon, 1:00 PM, and 2:00 PM on October 21 and November 21 to determine available sunlight on existing sunny public spaces.

In general, all shadows from individual buildings are short in length during the summer as a result of the higher solar altitude angle. Figure 6.3-1 demonstrates this by comparing the effect of solar altitude angle on shadow length at noontime for the summer, spring/fall, and winter analysis cases. During the vernal and autumnal equinox, shadows extend further from a building's base as the solar altitude angle is less than at summer. At the same time the lateral angle through which shadows sweep from morning to evening decreases as shown in Figure 6.3-2.

Nineteen figures, figures 6.3-3 through 6.3-21 (shown at the end of this chapter), present the horizontal shadow profile

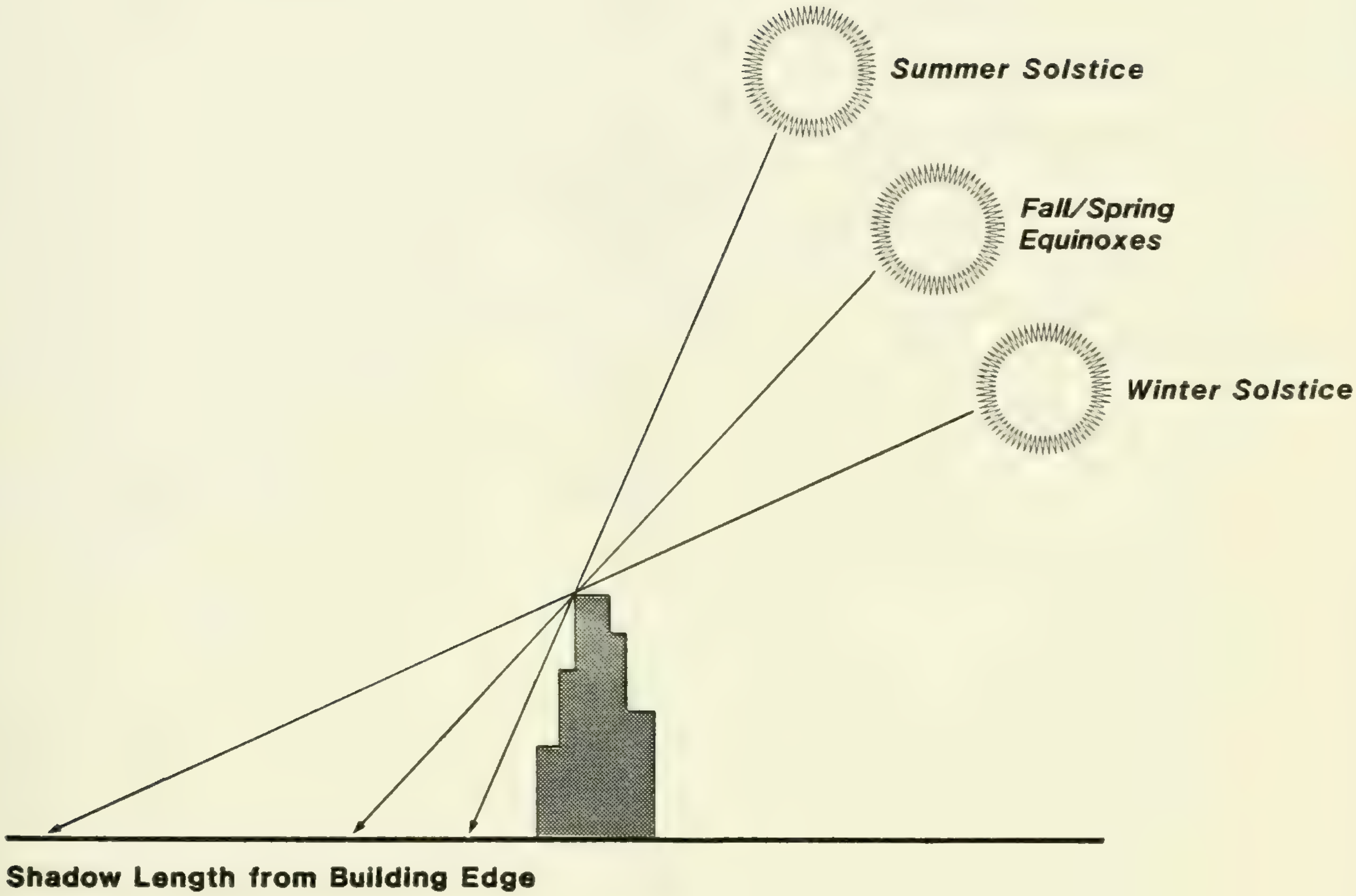


FIGURE 6.3-1 NOONTIME SOLAR ALTITUDE ANGLES

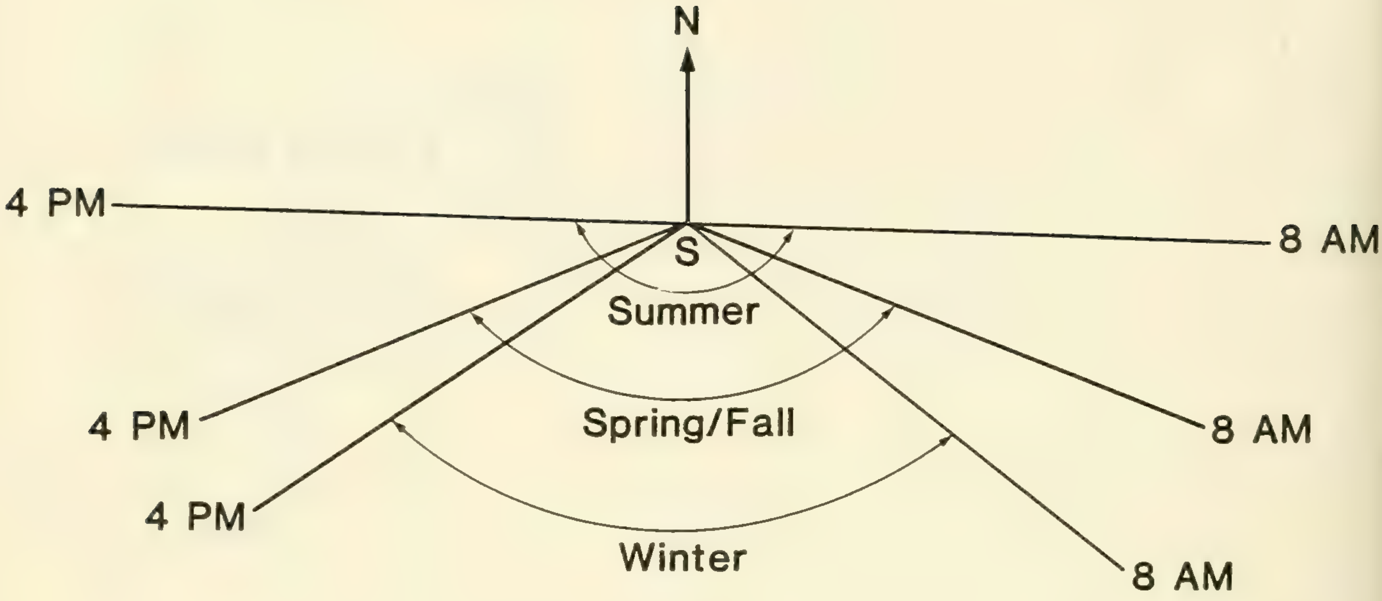


FIGURE 6.3-2 LATERAL SWEEP OF SUN'S PATH BY SEASON
(8:00 AM - 4:00 PM)

for each scenario. Existing profiles are outlined with a solid line, while the proposed building profile is outlined by a dashed line. The diagrams also show, in a light dot-pattern, existing shadows. Net new shadows associated with introduction of One Twenty Five High Street are indicated by the darker pattern. The net new shadow is essentially the measure of the project's shadow impact as it depicts the areas in which new shadows fall on previously sunny locations. Those areas within the profile of the proposed project that are shown with the lighter dot-pattern, represent areas where shadows of the project overlap with shadows of existing buildings.

During the summer, when people are frequently outdoors, shadow impacts are primarily limited to the streets adjacent to the project site. During the morning hours (Figure 6.3-3) net new shadows occur at a few rooftops and small sections of High Street and Pearl Street. By noontime (Figure 6.3-4), approximately two thirds of High Street, adjacent to the project site, is shaded. During the afternoon (Figure 6.3-5) hours, net new shadows are expected along much of Oliver Street, adjacent to the project site, and a small area of Purchase Street. No shadow impacts of the project are anticipated during the summer case at any of the public spaces noted above.

Net new shadows associated with the project at the vernal and autumnal equinox are expected along a block-long section of Pearl Street near the project site, High Street adjacent to the project's 21-story building, and the intersection of Pearl and Franklin Streets during the morning hours (Figure 6.3-6). Minimal new shadows were noted on a small portion of the proposed park at Post Office Square. As noon approaches, new shadows will move eastward impacting High Street and Oliver Street (Figure 6.3-7). By afternoon, new shadows at street level only occur on a small area along Purchase Street and across a section of the Central Artery adjacent to International Place (Figure 6.3-8). No new shadows were noted at existing public spaces, however, existing shadows were noted at Post Office Square during the morning hours and at the Custom House District during early- and mid-afternoon.

During winter, shadows reach maximum lengths such that most pedestrian level locations are shaded by existing buildings. During the morning hours, as depicted in Figure 6.3-9, the net new shadows from One Twenty Five High Street will be found on rooftops, a narrow strip of Pearl Street up to Congress Street, and a narrow strip of Oliver Street northwest of the project site. Some additional shading is expected along High Street adjacent to the project. By noontime (Figure 6.3-10), very few new shadows are anticipated. These are found at High Street near the intersection with Pearl Street, as well as the intersection of Broad and Franklin Streets in the Custom House District. By mid-afternoon, only minimal net new shadow is expected at pedestrian levels (Figure 6.3-11) and a small area of net new shading was found at the waterfront between Long Wharf and the New England Aquarium.

During early- to mid-autumn, represented by the October 21 shadow diagrams, the shadow profile of One Twenty Five High Street begins to extend about four to five hundred feet from the project site. During the mid-morning hours, as seen in Figure 6.3-12, new shadows will be found at rooftops and along High Street and Oliver Street primarily around these intersections. By late morning and noontime (Figures 6.3-13 and 6.3-14), the majority of street level net new shadows are primarily found along Oliver Street adjacent to the project and a section of High Street from Oliver Street to Batterymarch Street. During the early and mid-afternoon hours (Figures 6.3-15 and 6.3-16), existing shadows expand significantly such that the bulk of the new shadows are only found at rooftops and small sections of Oliver and High Streets. Only a small area at the southwest edge of the Custom House District is impacted early in the afternoon.

During late autumn, represented by November 21, net new shadows at street level during the morning hours (Figures 6.3-17 and 6.3-18) occur around the intersection of High Street and Oliver Street and a very small portion of High Street near the intersection with Pearl Street. At noontime and during the very early afternoon (Figures 6.3-19 and 6.3-20), net new shadows

will disperse with only small impacts to High, Oliver, and Batterymarch Streets. By mid-afternoon (Figure 6.3-21), the only notable net new shadow is expected across the Central Artery near the intersection of Atlantic Avenue and East India Row. No new shadow impacts are anticipated at the public spaces listed above, except a small area near the Batterymarch/High Street intersection at the southwest corner of the Custom House District and a small area along Broad Street during the early afternoon.

In summary, shadow diagrams demonstrate that the majority of net new shadow results from One Twenty Five High Street occur at pedestrian levels adjacent to the project and some rooftops away from the project site. Most noticeable impacts are anticipated during the late spring and early fall. Areas impacted during this period will primarily include High Street and Oliver Street, and portions of Purchase Street and Pearl Street (up to Franklin Street). These impacts, however, are dispersed throughout the daylight hours. Shadows during hot summer days are generally welcomed by pedestrians and by late fall through early spring the project area is already heavily shaded under existing conditions.

Specific impacts on each of the shadow sensitive public areas were incorporated into the study. There are no impacts from the proposed project on the following areas:

- o Winthrop Square
- o Daniel Webster Park
- o Fanieul Hall/Quincy Market
- o City Hall Plaza

From mid-autumn through late-autumn, likewise early- through mid-spring, only minimal new impacts were noted at the Custom House District around noontime and very early afternoon. During the winter solstice (December 22), and spring/fall equinox morning shadows do intrude on a small portion of Pearl Street in the vicinity of Post Office Square. These shadows do not, however, impact the park and seating areas at Post Office Square.

HORIZONTAL SHADOW PROF
EXISTING SHADOW PROFILE
EXISTING SHADOW
NET NEW SHADOW

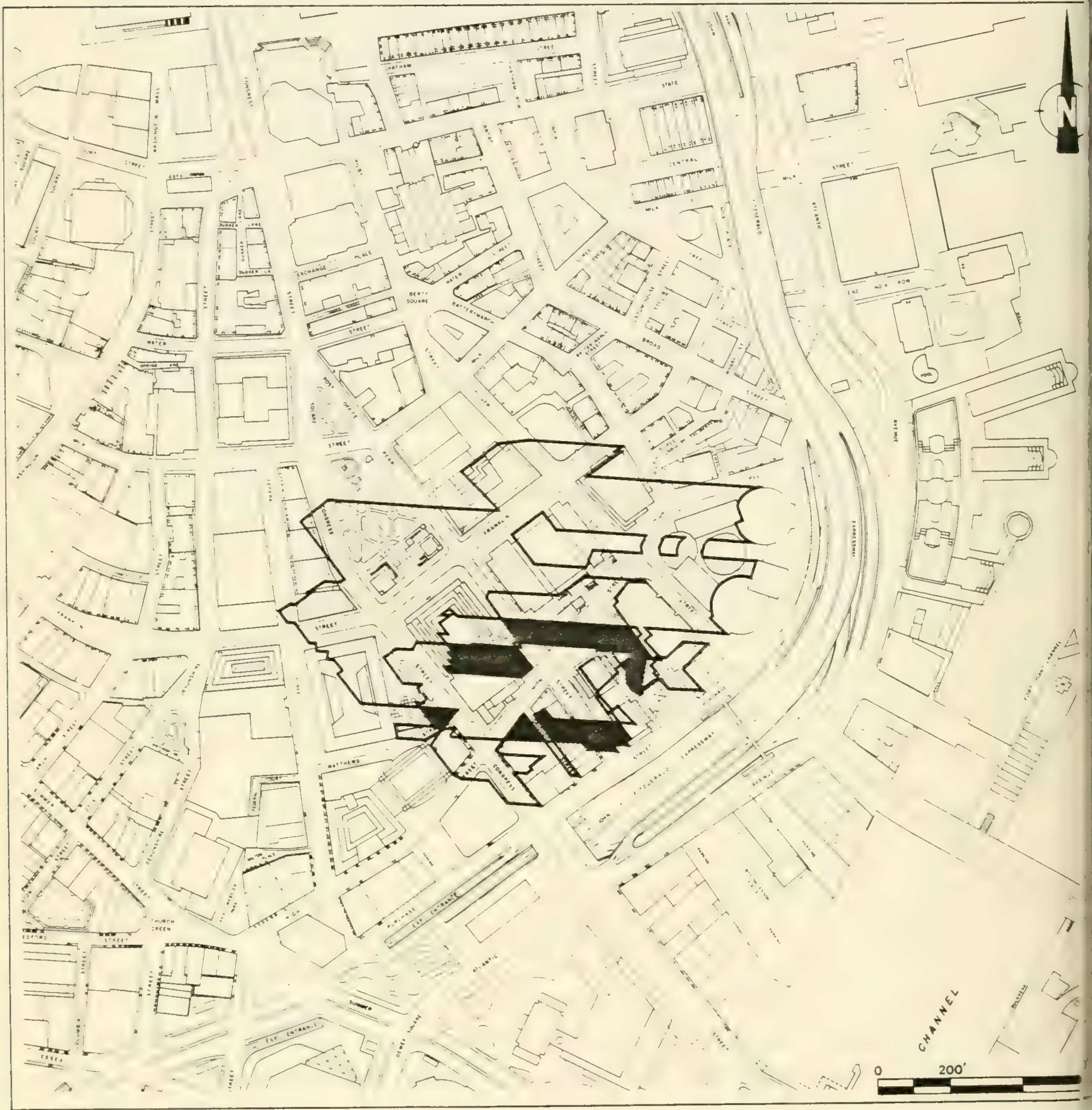


FIGURE 6.3-3 HORIZONTAL SHADOW PROFILE/EXISTING AND NET NEW SHADOWS - JUNE 22, 9:00 AM

FIGURE 6.3-4 HORIZONTAL SHADOW PROFILE/EXISTING AND NET NEW SHADOWS - JUNE 22, 12:00 NOON

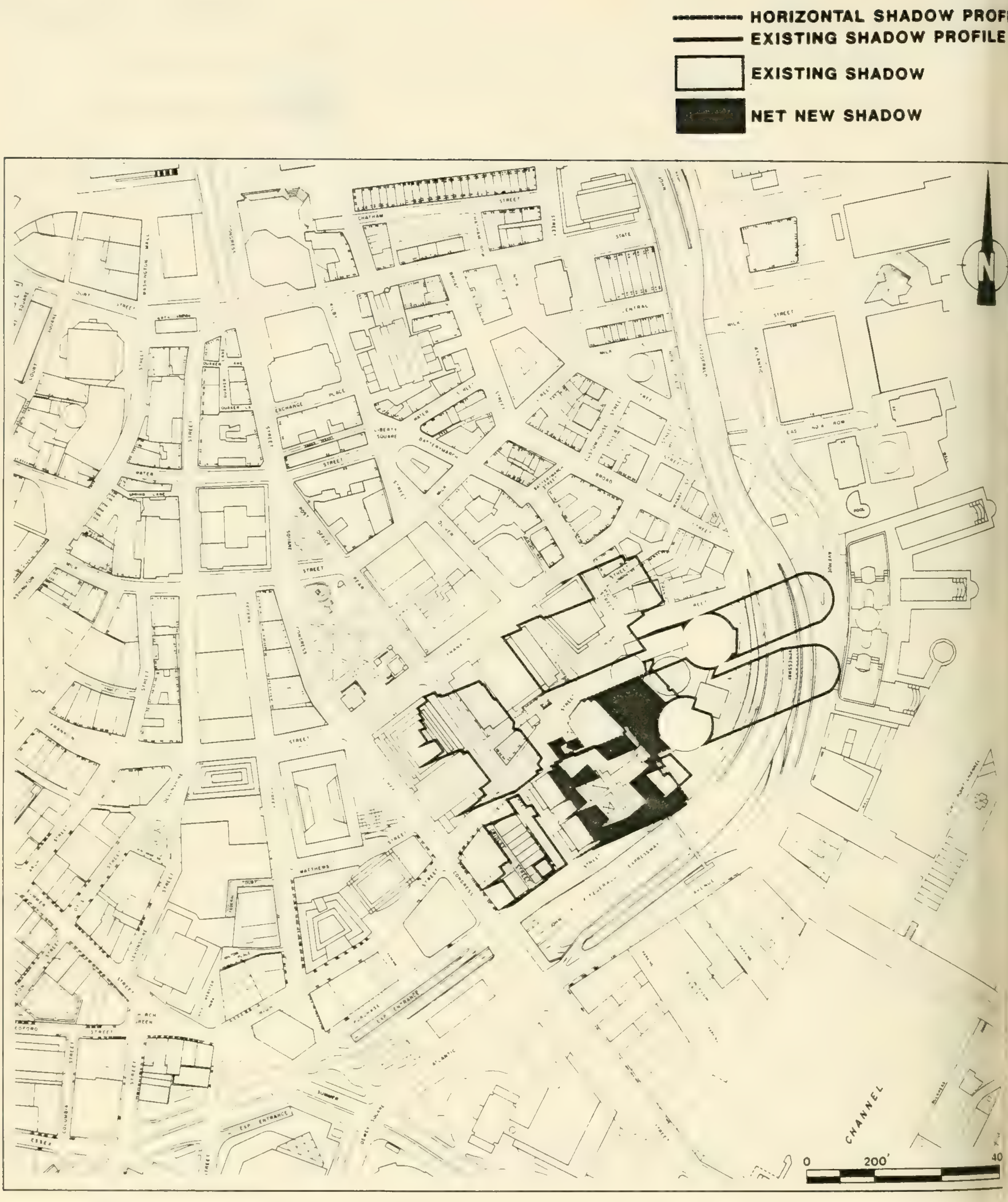


FIGURE 6.3-5 HORIZONTAL SHADOW PROFILE/EXISTING AND NET NEW SHADOWS - JUNE 22, 3:00 PM

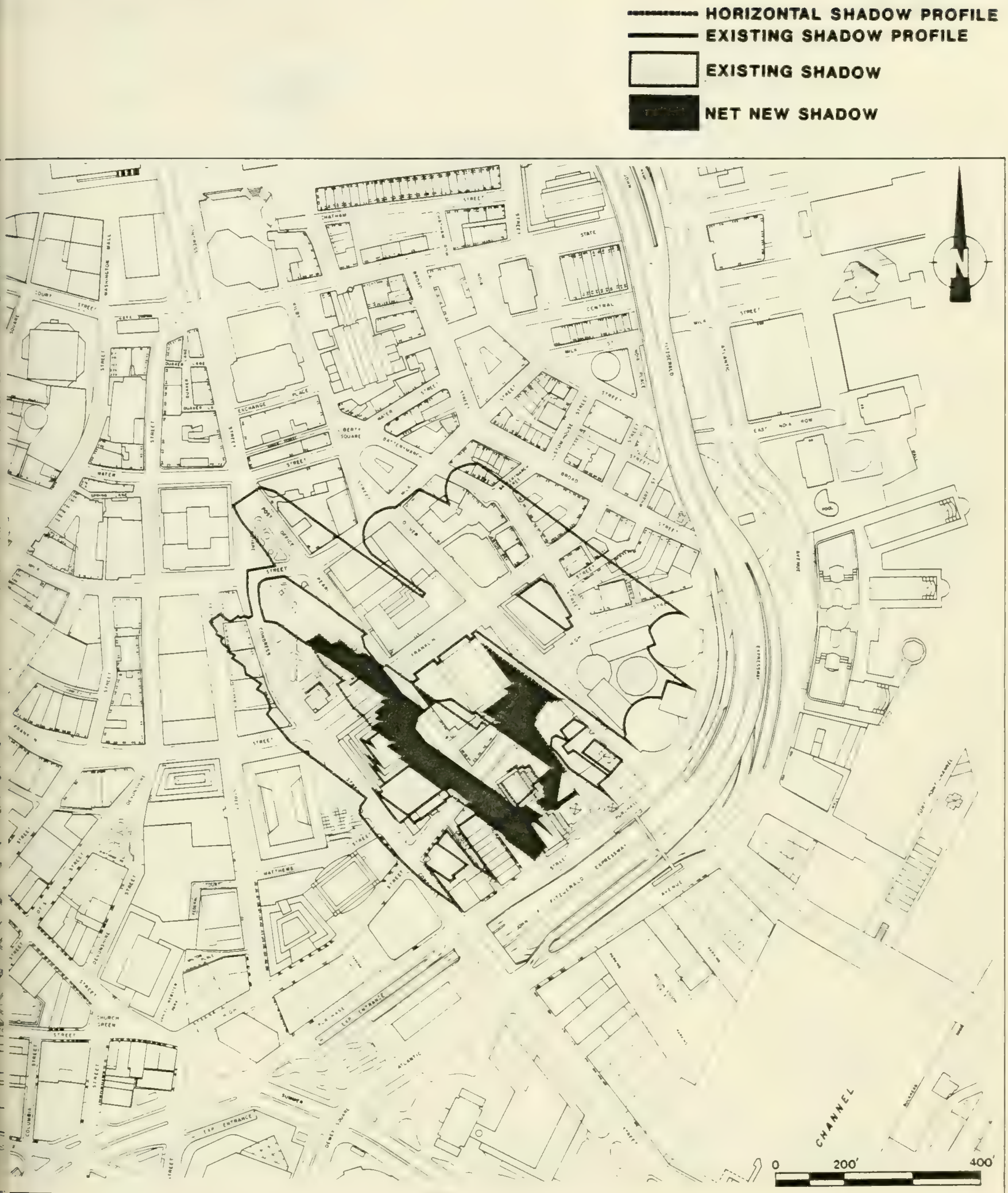


FIGURE 6.3-6 HORIZONTAL SHADOW PROFILE/EXISTING AND NET NEW SHADOWS - MARCH 21/SEPTEMBER 23, 9:00 AM

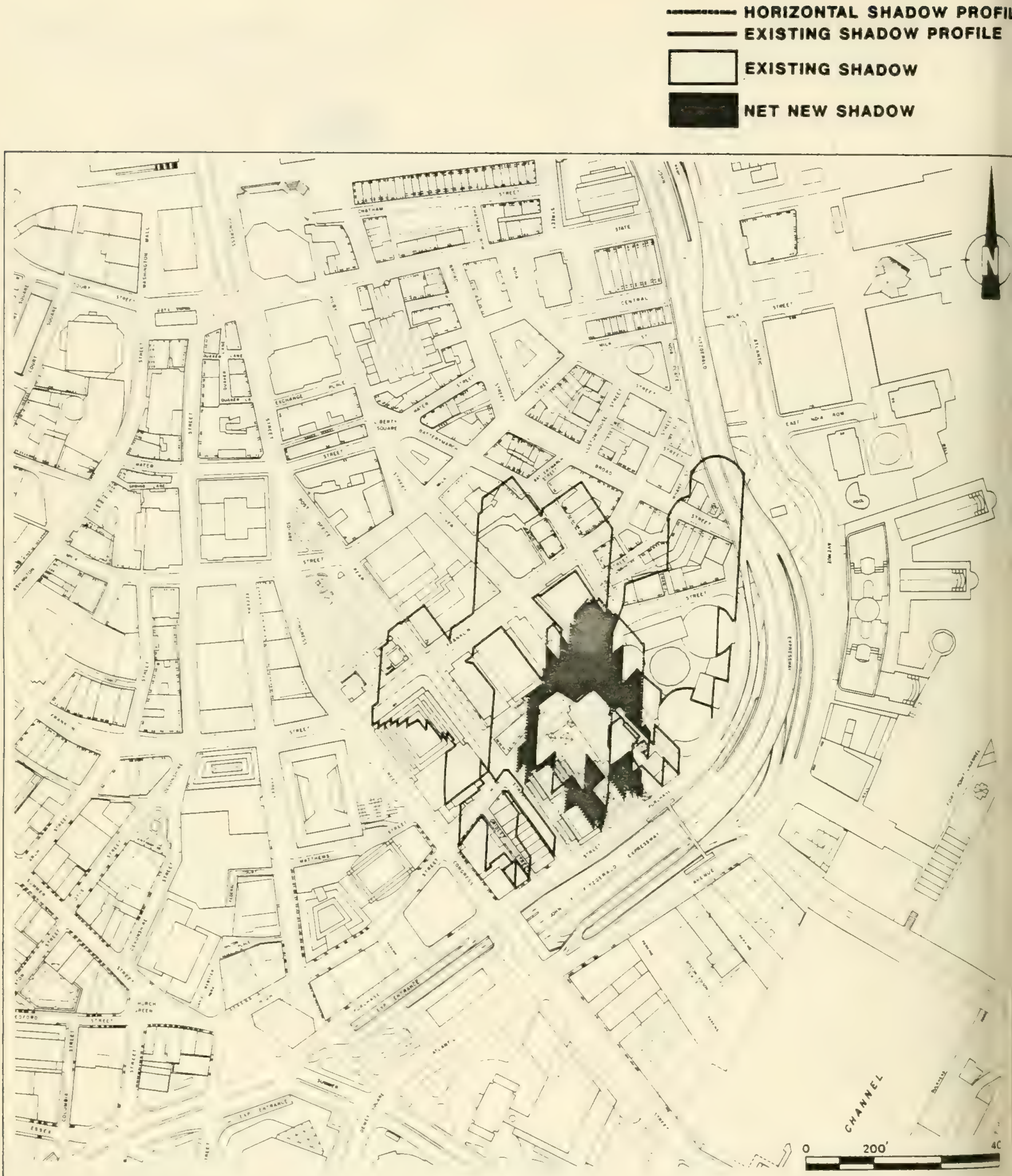


FIGURE 6.3-7 HORIZONTAL SHADOW PROFILE/EXISTING AND NET NEW SHADOWS - MARCH 21/SEPTEMBER 22, 12:00 NOON

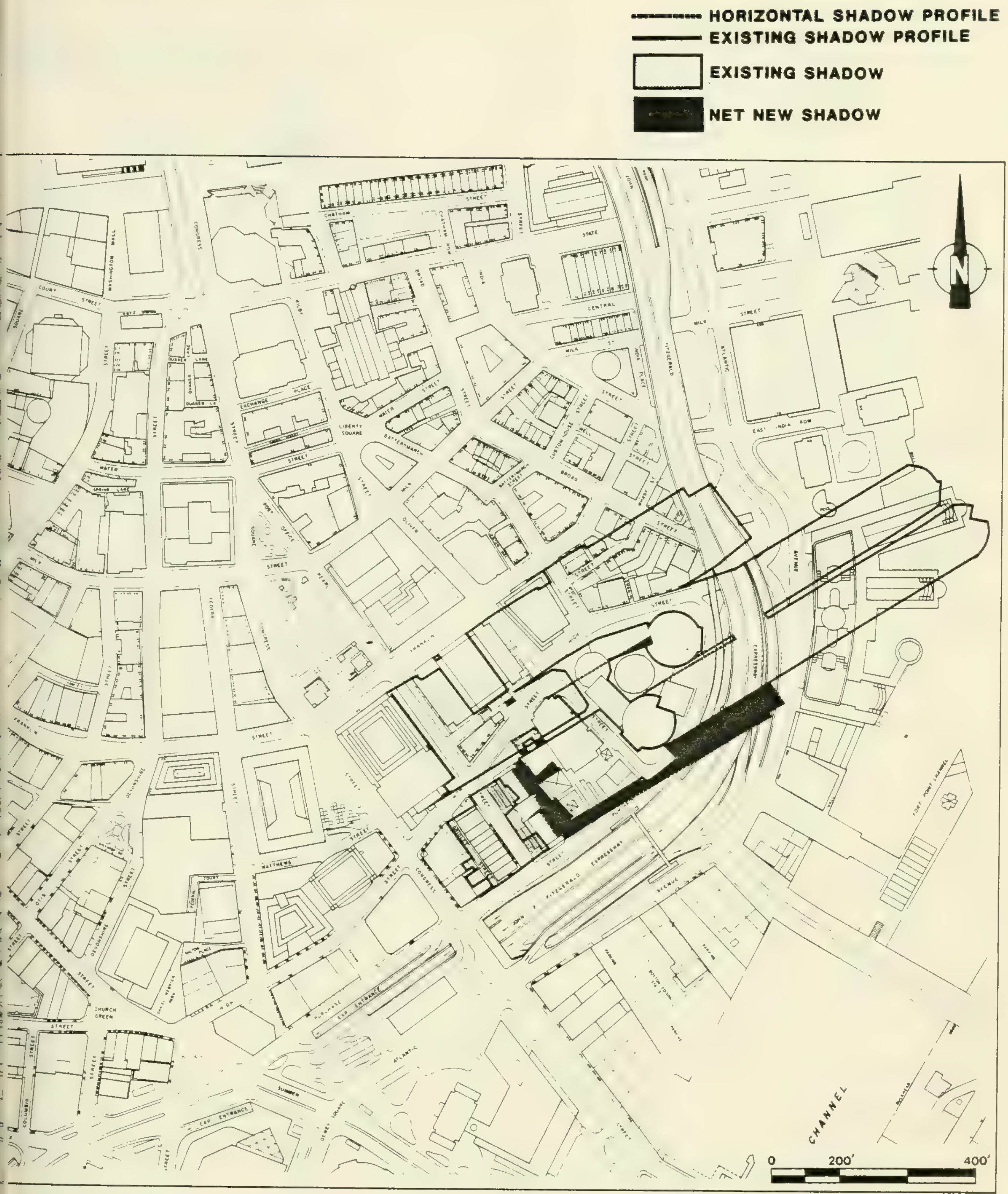


FIGURE 6.3-8 HORIZONTAL SHADOW PROFILE/EXISTING AND NET NEW SHADOWS - MARCH 21/SEPTEMBER 23, 3:00 PM

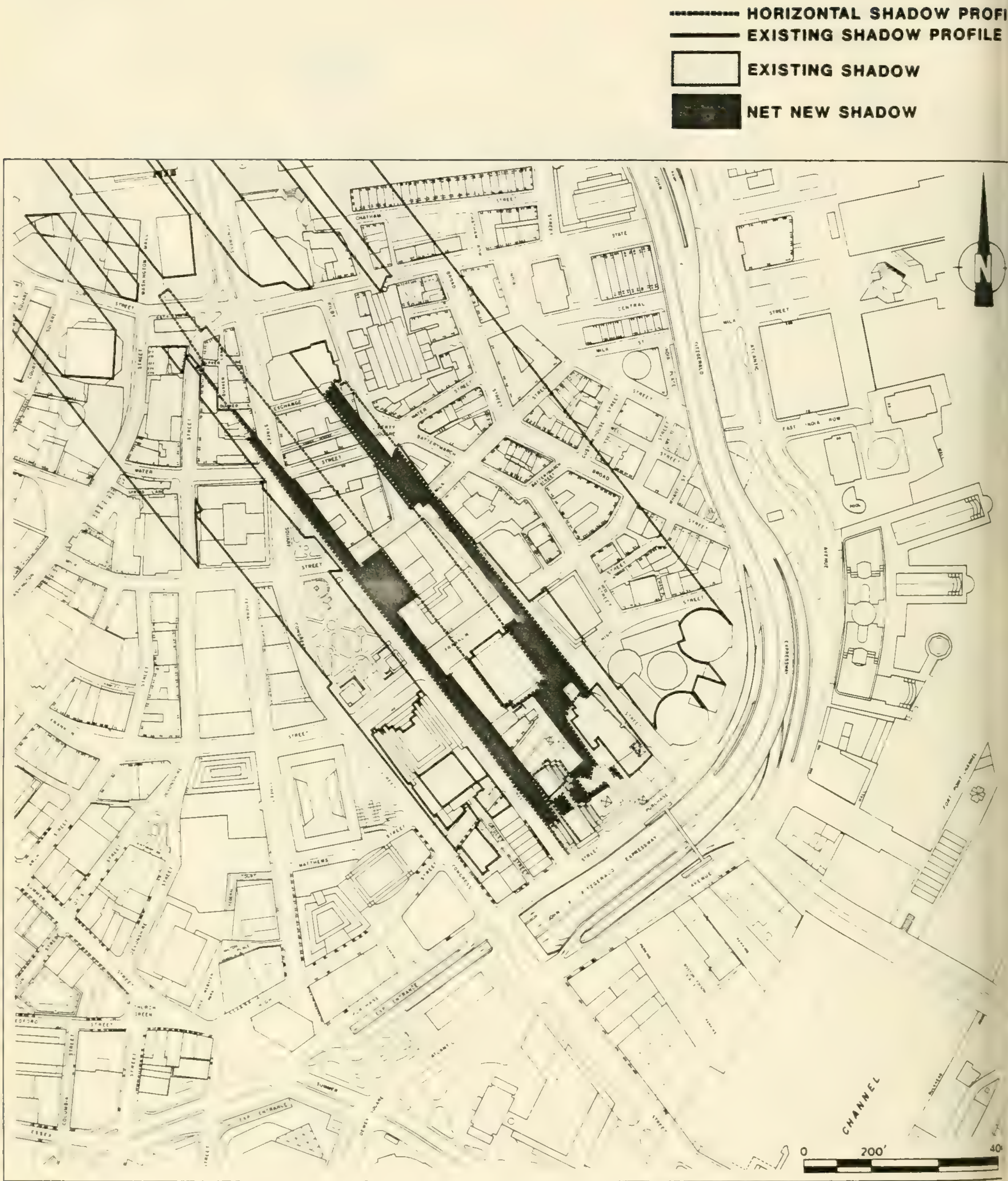


FIGURE 6.3-9 HORIZONTAL SHADOW PROFILE/EXISTING AND NET NEW SHADOWS - DECEMBER 22, 9:00 AM

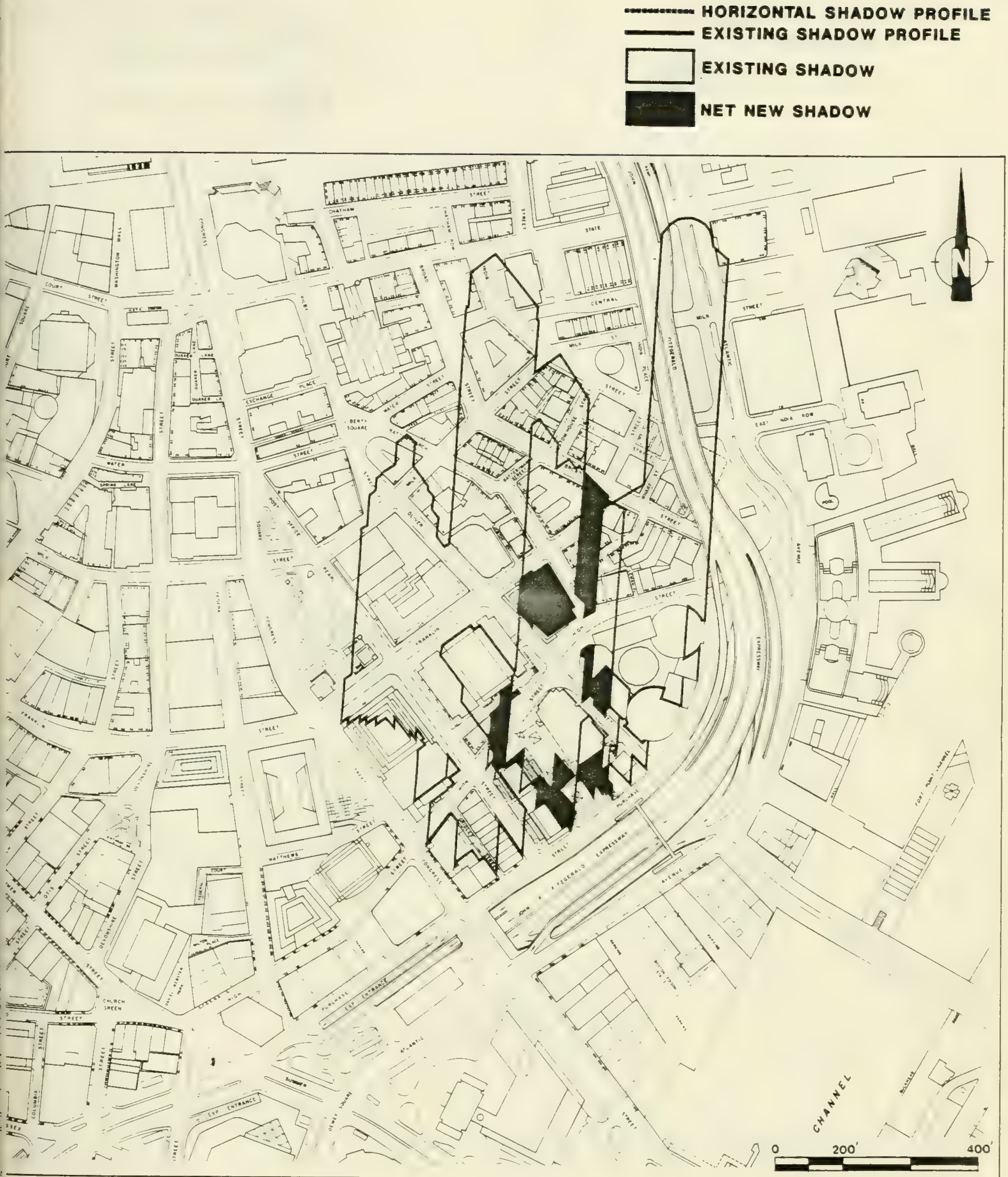


FIGURE 6.3-10 HORIZONTAL SHADOW PROFILE/EXISTING AND NET NEW SHADOWS - DECEMBER 22, 12:00 NOON

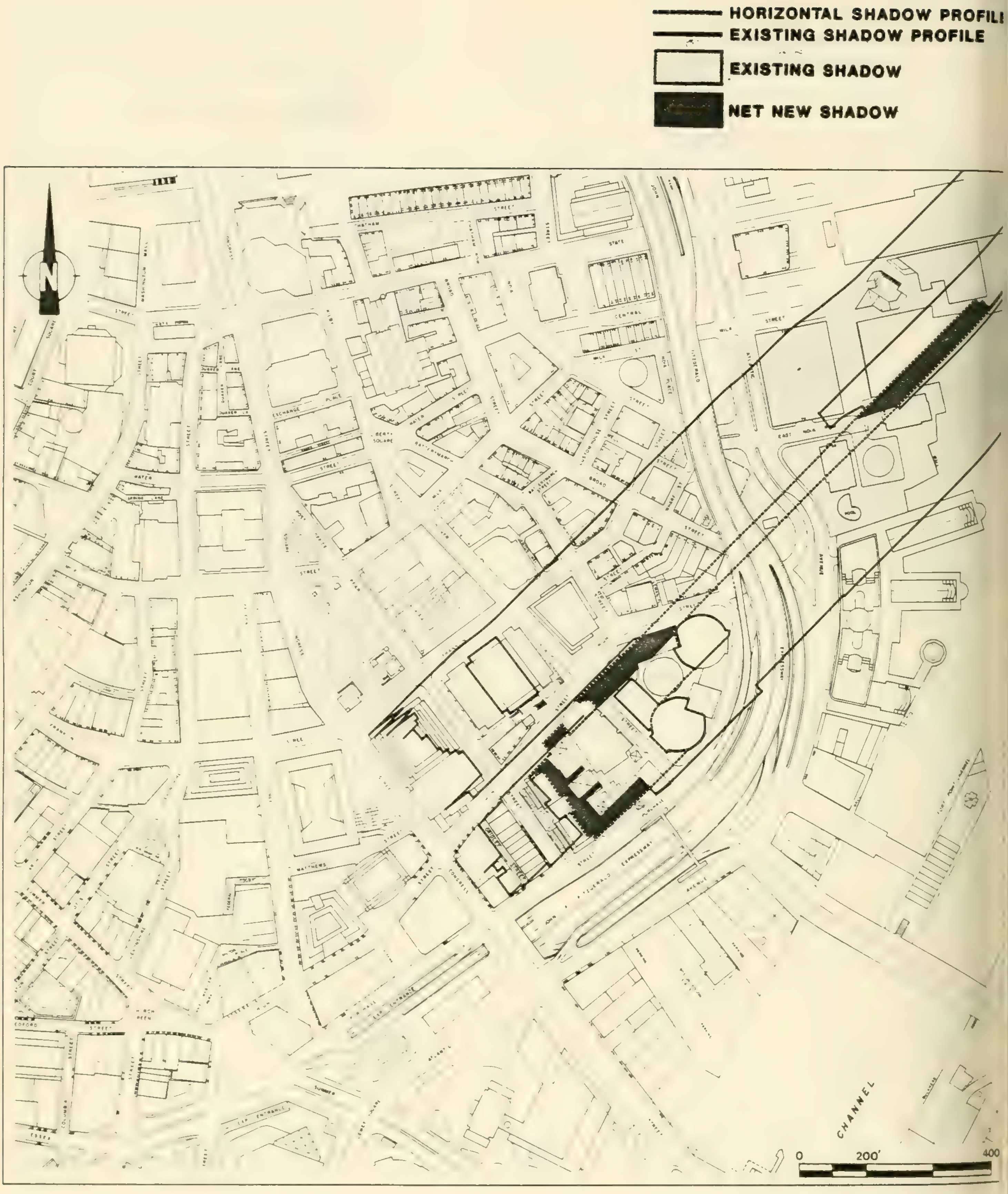


FIGURE 6.3-11 HORIZONTAL SHADOW PROFILE/EXISTING AND NET NEW SHADOWS - DECEMBER 22, 3:00 PM

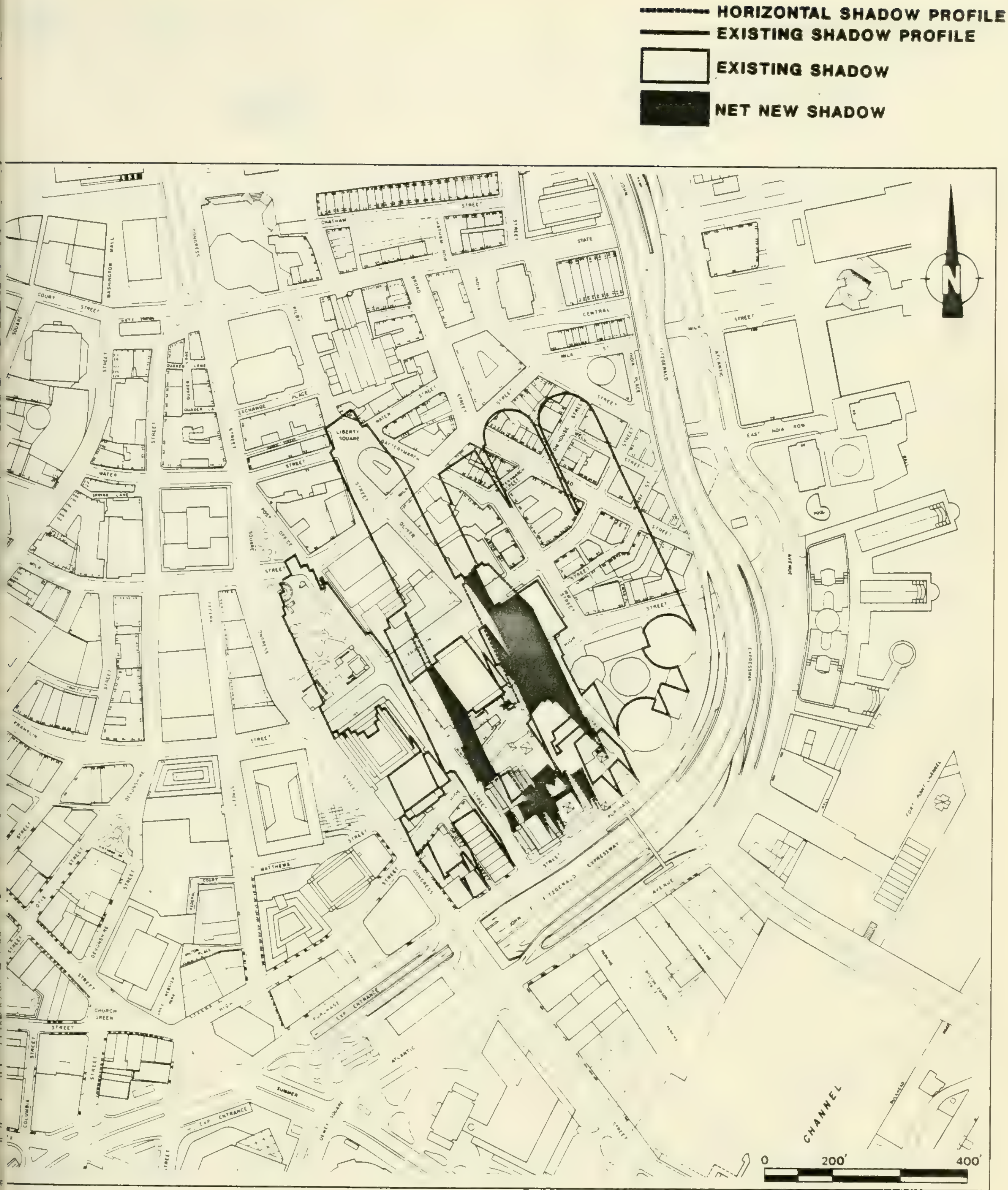


FIGURE 6.3-12 HORIZONTAL SHADOW PROFILE/EXISTING AND NET NEW SHADOWS - OCTOBER 21, 10:00 AM

FIGURE 6.3-13 HORIZONTAL SHADOW PROFILE/EXISTING AND NET NEW SHADOWS - OCTOBER 21, 11:00 AM

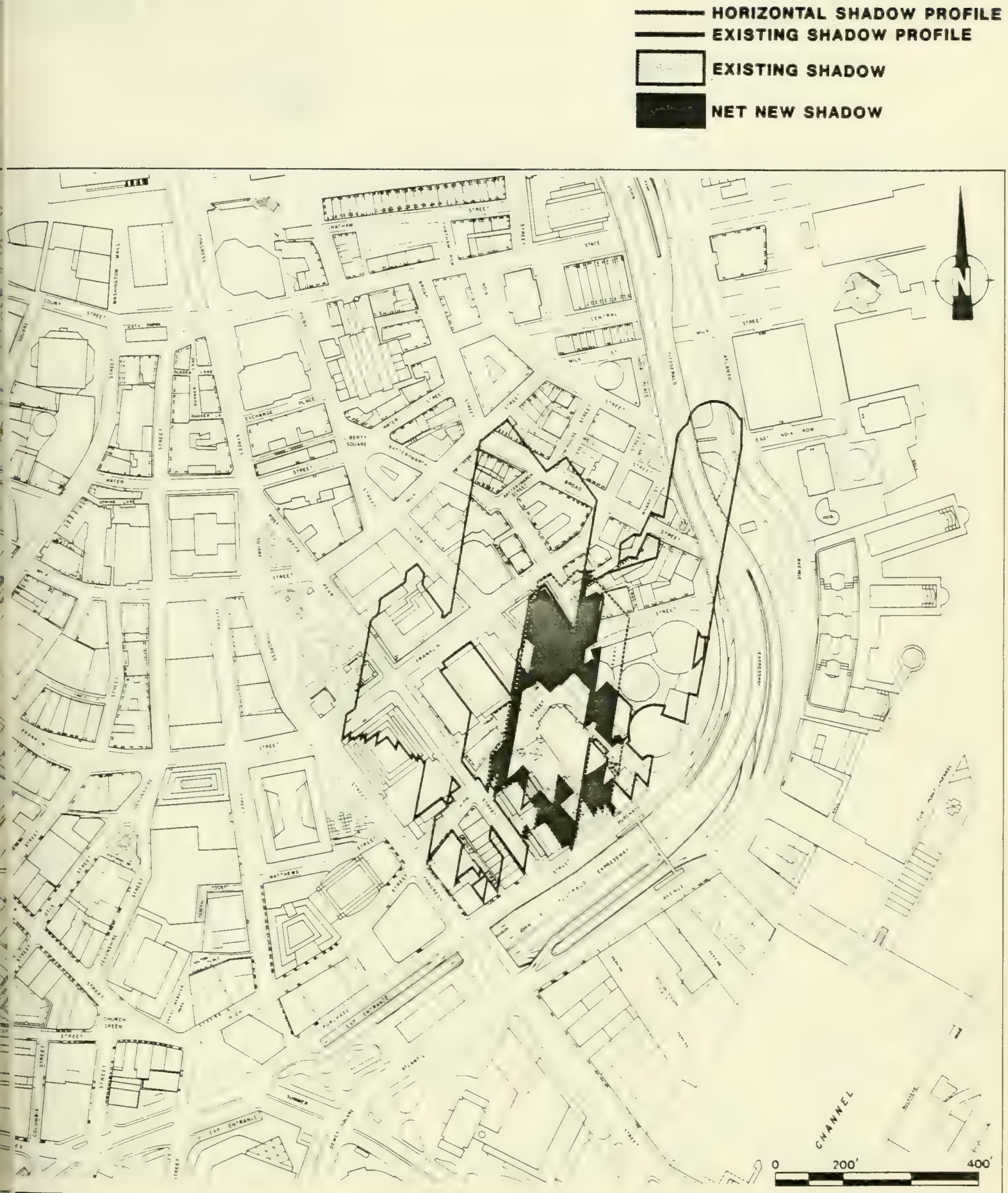


FIGURE 6.3-14 HORIZONTAL SHADOW PROFILE/EXISTING AND NET NEW SHADOWS - OCTOBER 21, 12:00 NOON

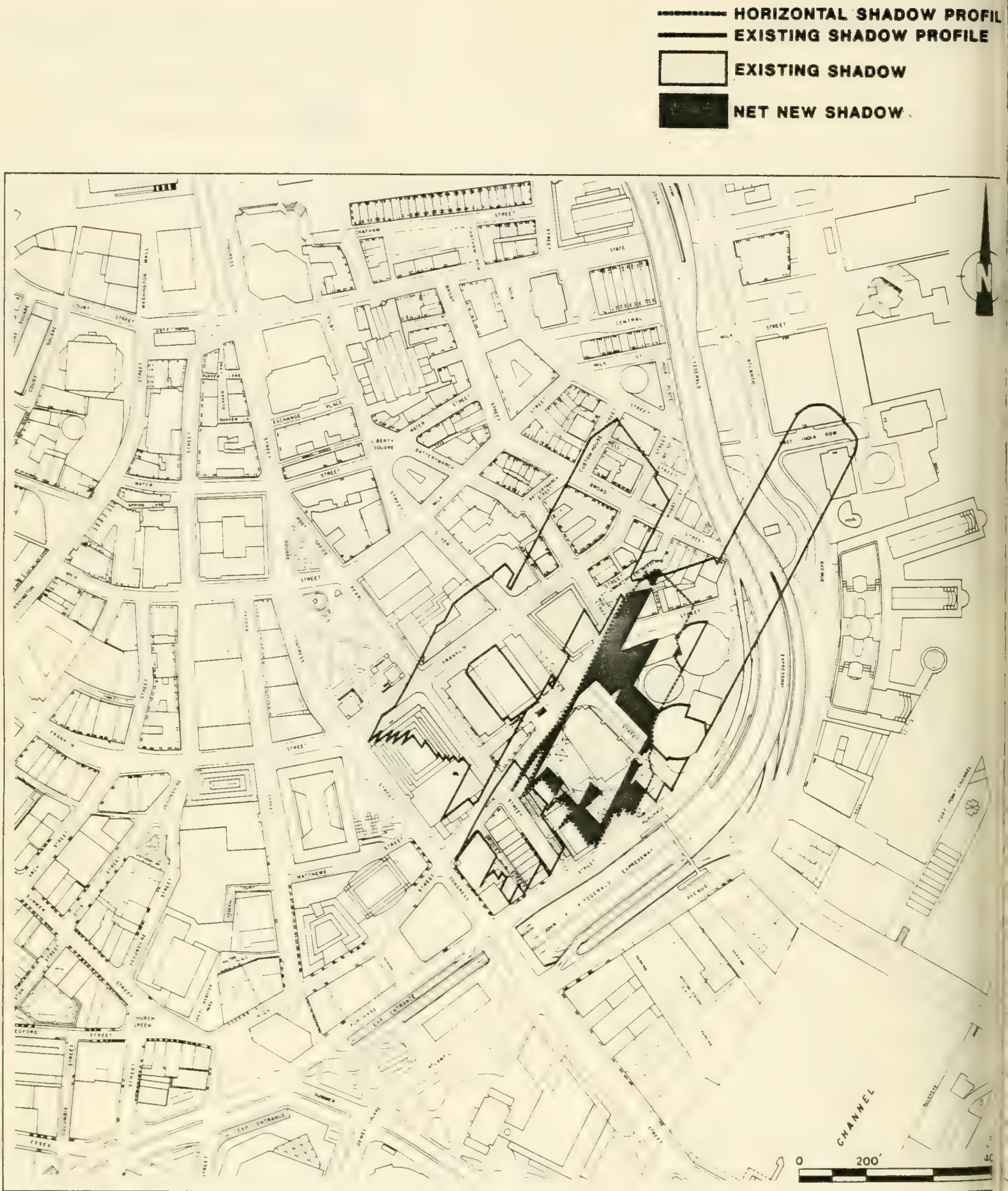


FIGURE 6.3-15 HORIZONTAL SHADOW PROFILE/EXISTING AND NET NEW SHADOWS - OCTOBER 21, 1:00 PM

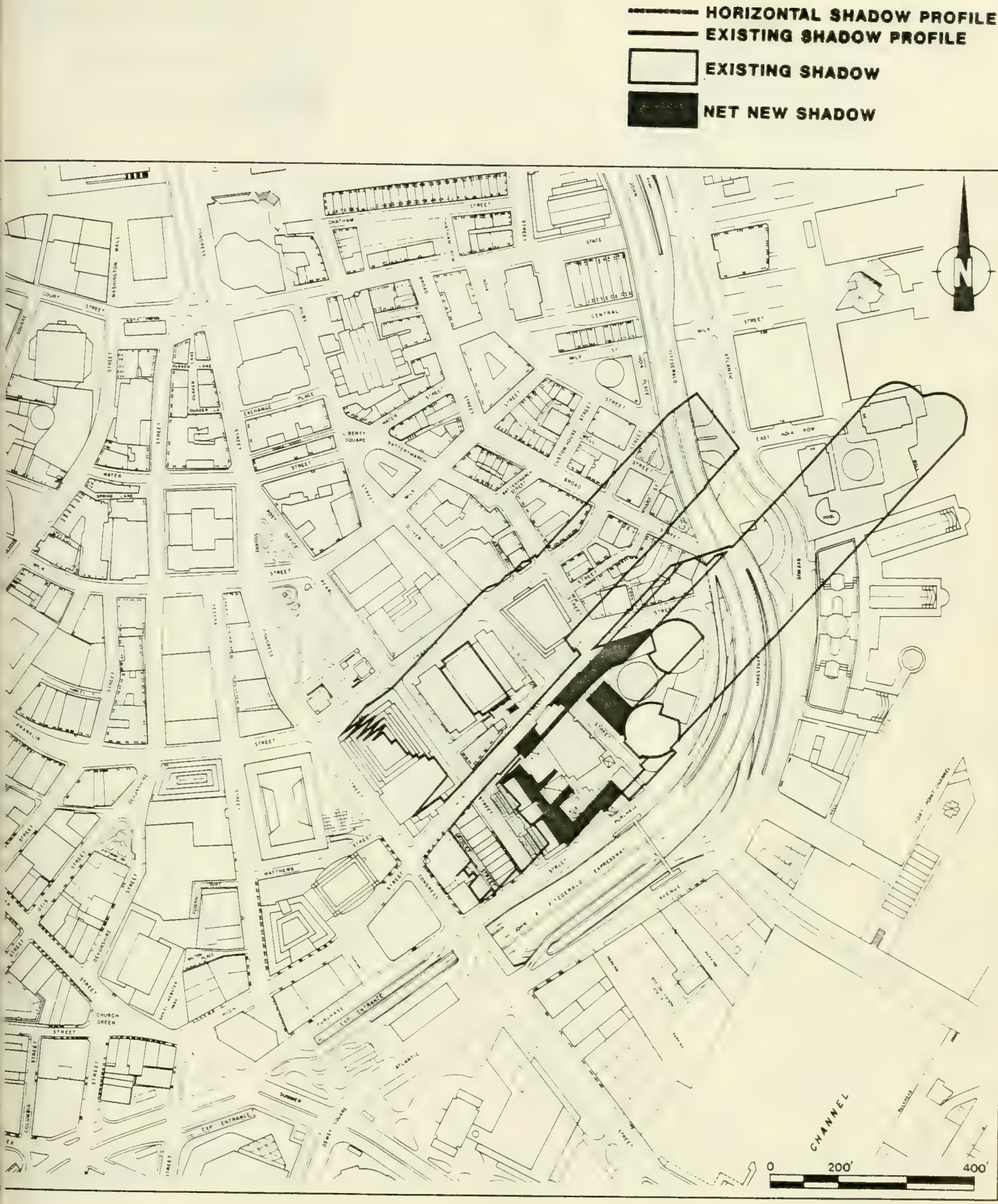


FIGURE 6.3-16 HORIZONTAL SHADOW PROFILE/EXISTING AND NET NEW SHADOWS - OCTOBER 21, 2:00 PM

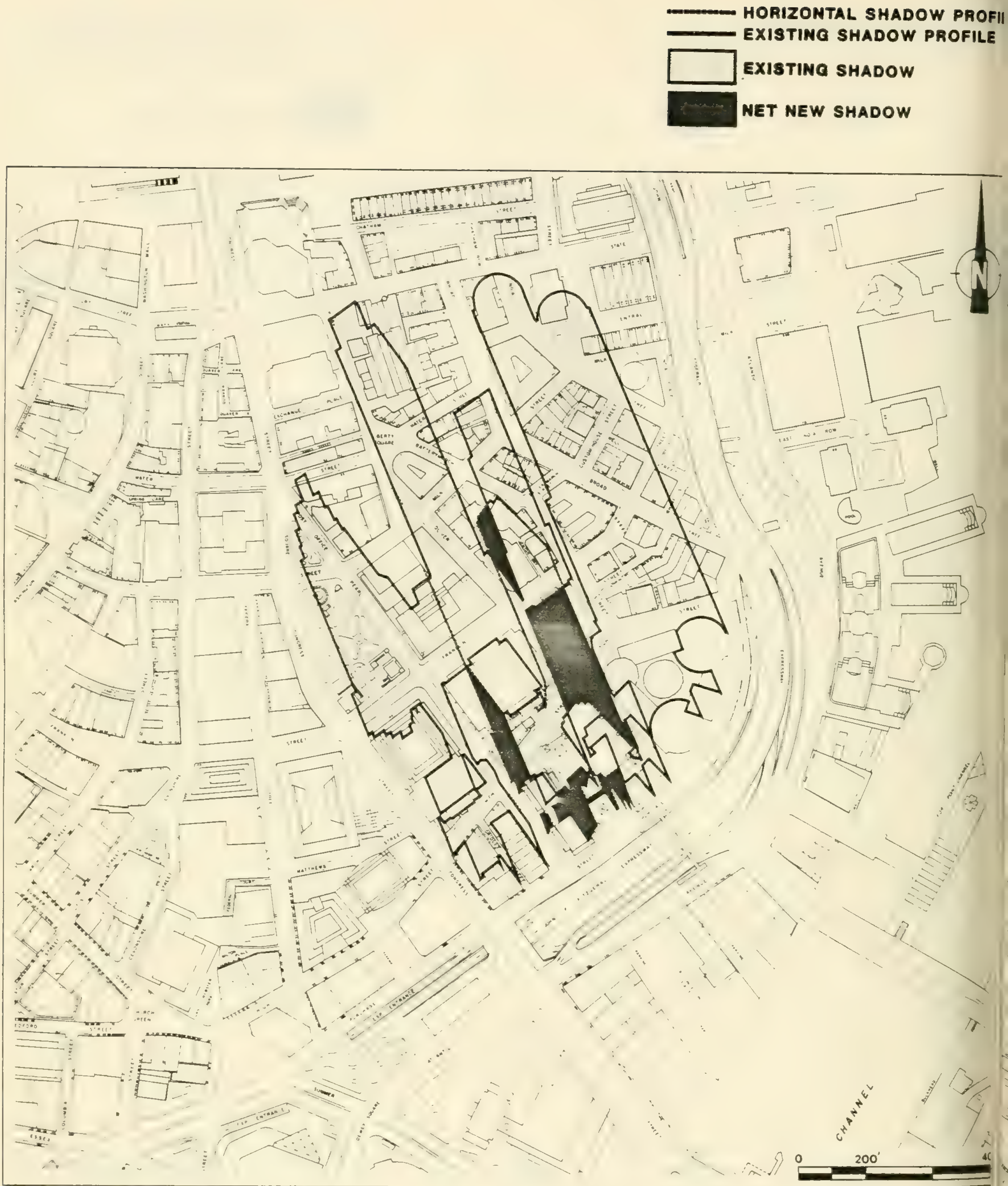


FIGURE 6.3-17 HORIZONTAL SHADOW PROFILE/EXISTING AND NET NEW SHADOWS - NOVEMBER 21, 10:00 AM

FIGURE 6.3-18 HORIZONTAL SHADOW PROFILE/EXISTING AND NET NEW SHADOWS - NOVEMBER 21, 11:00 AM

FIGURE 6.3-19 HORIZONTAL SHADOW PROFILE/EXISTING AND NET NEW SHADOWS - NOVEMBER 21, 12:00 NOON

HORIZONTAL SHADOW PROFILE
EXISTING SHADOW PROFILE
EXISTING SHADOW
NET NEW SHADOW

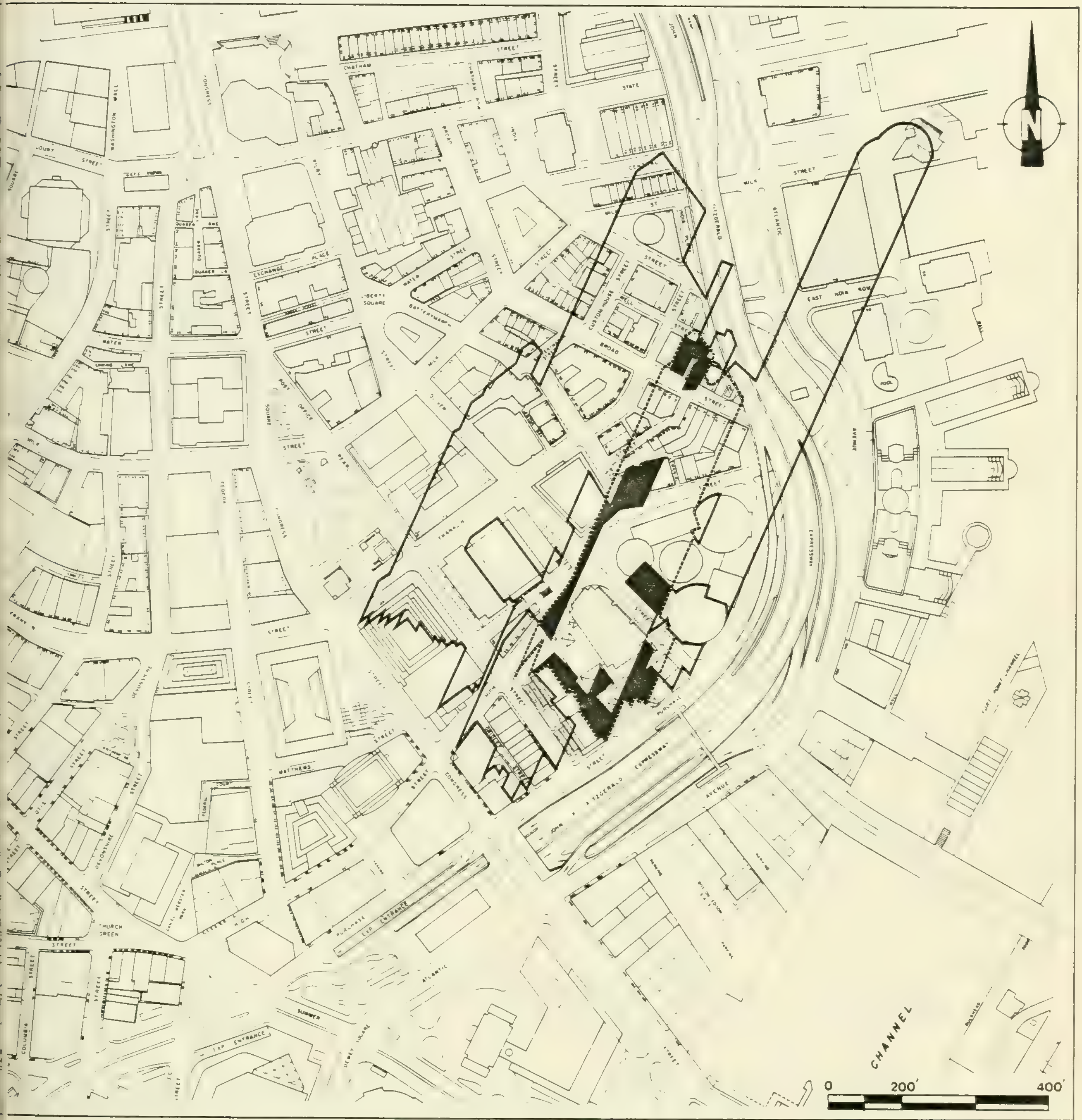


FIGURE 6.3-20 HORIZONTAL SHADOW PROFILE/EXISTING AND NET NEW SHADOWS - NOVEMBER 21, 1:00 PM

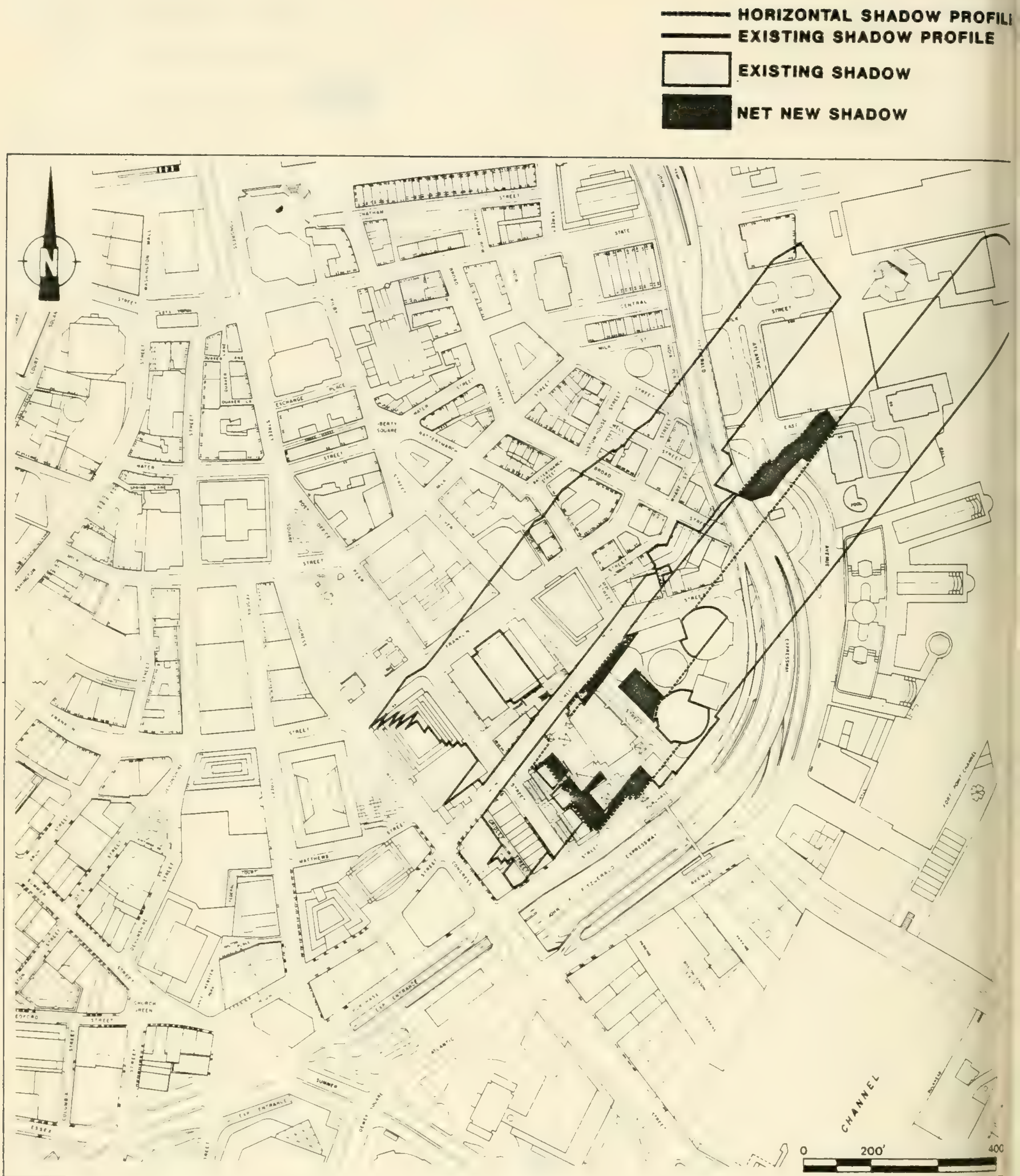


FIGURE 6.3-21 HORIZONTAL SHADOW PROFILE/EXISTING AND NET NEW SHADOWS - NOVEMBER 21, 2:00 PM

6.4 DAYLIGHT

The purpose of the daylight study is to determine the extent to which One Twenty Five High Street would affect perceived daylight at street level. The analysis compares the existing conditions to full build configurations. Attention was given to the proposed buildings' design features that would preserve potential sunlight such as setbacks and notching of corners.

The daylight study for One Twenty Five High Street was performed utilizing the Boston Redevelopment Authority's computer software (BRADA).[1] BRADA is based on a "fish eye" view of the project from ground level at the center of an adjacent city street looking skyward (see Figure 6.4-1[2]). From this street level perspective, the model plots the project's base, setbacks, and other features to a "fish eye" view map using lateral and elevation angles. These angles are calculated internally using tier heights, distances from the street level and property reference points, and simple geometry. A plot plan of the project site and the observation point for each of the four adjacent streets is shown in Figures 6.4-2 and 6.4-3 for the proposed and existing configuration, respectively. For each of the eight observation point/project configuration schemes a BRADA modeling run was performed. Plots for each of these are presented in Figure 6.4-4 through 6.4-11. These figures provide a simplified block-like elevation view of project elements to the left, in addition to the "fish eye"

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[1] Harvey Bryan and Susan Stuebing, "Boston Redevelopment Authority Daylight Analysis (BRADA)," MIT, Cambridge Massachusetts

[2] Harvey Bryan and Susan Stuebing, "Zoning For Daylight, Referencing the Past to Building Cities for the Future," School of Architecture, MIT, Cambridge, Massachusetts.

Also note: All figures are grouped at the end of this chapter for continuity.

perspectives used to determine daylight obstruction. Note, that from street level, directly adjacent to the project site, many of the set-back upper level roof top features are hidden. In addition, the BRADA program assumes all building elements to be block-like. Percent of daylight obstructed for both the existing and full build configurations are summarized in Table 6.4-1. Results of each elevation are discussed below.

<u>High Street Elevation</u>

Figure 6.4.4 presents a "fish eye" view of the project from location A1 (see Figure 6.4-2 and 6.4-3) on High Street. This diagram demonstrates that the project's lower infill base (typically 5 stories) and 21-story building at the High Street/Oliver Street corner to be the primary obstructions to daylight. A comparison of the elevation view to the "fish eye" view in Figure 6.4-4, demonstrates the benefits of the set back of the 30-story building in reducing obstruction of daylight. Results of the analysis demonstrated that 51.5% of available daylight will be blocked out by the proposed project as opposed to 23.1% under the existing configuration (see Figure 6.4-5).

<u>Oliver Street Elevation</u>

The "fish eye" view of the project's east elevation from Oliver Street (see location A2 on Figures 6.4-2 and 6.4-3) is diagrammed in Figure 6.4-6. The view demonstrates that the 21-story building at the corner of High Street and Oliver Street is the dominant feature of the project from this perspective. Figure 6.4-7 presents a similar "fish eye" view of the existing configuration. The results indicate 72.1% of available daylight will be blocked out by the proposed project while 41.2% is blocked out by existing buildings.

Purchase Street Elevation

The Purchase Street elevation views, shown in Figures 6.4-8 and 6.4-9 are based on mappings of the proposed and existing buildings, respectively, from observation point A3 in Figure 6.4-2 and 6.4-3. The prominent features of the project from this point is the infill base building which houses the proposed new fire station. Since the 30-story building at the corner of Purchase and Pearl Street is placed at the left edge of the property line, its skywood viewing impact is minimized from observation point A3. However, the project still obstructs approximately 74% of available day light as opposed to about 25% under the existing configuration.

Pearl Street Elevation

Figures 6.4.10 and 6.4.11 present the "fish eye" view of the project and existing buildings, respectively from point A4 (see Figure 6.4-2 and 6.4-3) on Pearl Street. From this location, the 30-story building along Pearl Street is the prominent feature affecting perceived daylight at ground level. The narrowness of Pearl Street, which in addition to the project, results in 88.5 percent of daylight obstructed. The analysis demonstrated 45.5 percent of available daylight to be blocked by the existing buildings.

The mapping results indicate that under the existing configuration low daylight obstruction percentages are noted as the present buildings, except along Oliver Street, are set well back from the property line. The daylight analysis of the project demonstrates that the location of the proposed buildings directly against the property line have the effect of reducing perceived daylight. However, the setback of the 30-story building along High Street, and to a lesser extent along Pearl Street, will allow additional daylight to the street level.

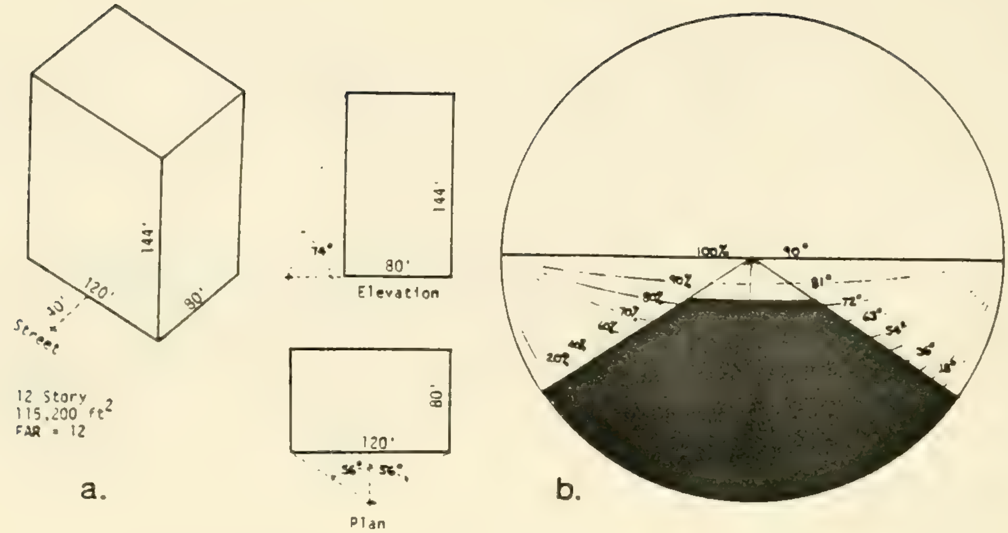
In summary, the configuration of the existing buildings on the site, with considerable setbacks and surface parking, does permit more perceived daylight at street level than will the proposed configuration. While the latter does reduce the percentage of perceived daylight from the street level, the new buildings, which will be very close to the property lines, afford the opportunity for pedestrian arcades at street level, multiple entrances to the complex, shelter from cold and/or inclement weather, and many amenities that an "open" configuration could not offer.

TABLE 6.4-1

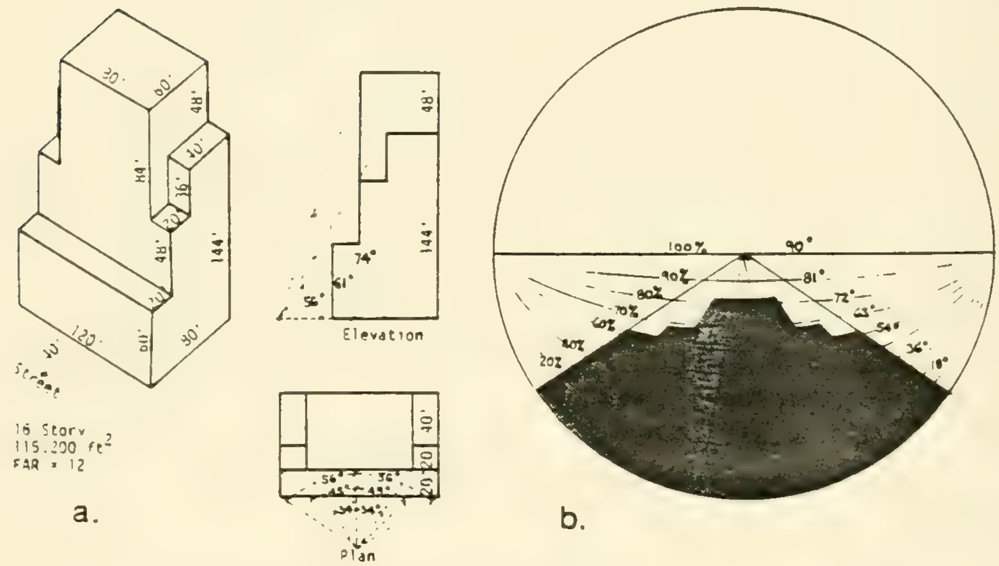
PERCENT DAYLIGHT OBSTRUCTED

Elevation	Street	Percent Daylight Obstructed* Proposed Project	Existing Buildings	Difference
North	High	51.5	23.1	28.4
East	Oliver	72.1	41.2	30.9
South	Purchase	73.9	24.8	49.1
West	Pearl	88.5	45.5	43.0
Average		71.5	33.7	

* The values do not include a reduction factor based on surface reflectance effects.



Proposed building designed as a rectangular solid, with an 82% obstruction to the street



Proposed building designed to set back on the site, with an 75% obstruction to the street

FIGURE 6.4-1 "FISH EYE" VIEW AT GROUND LEVEL LOOKING SKYWARD

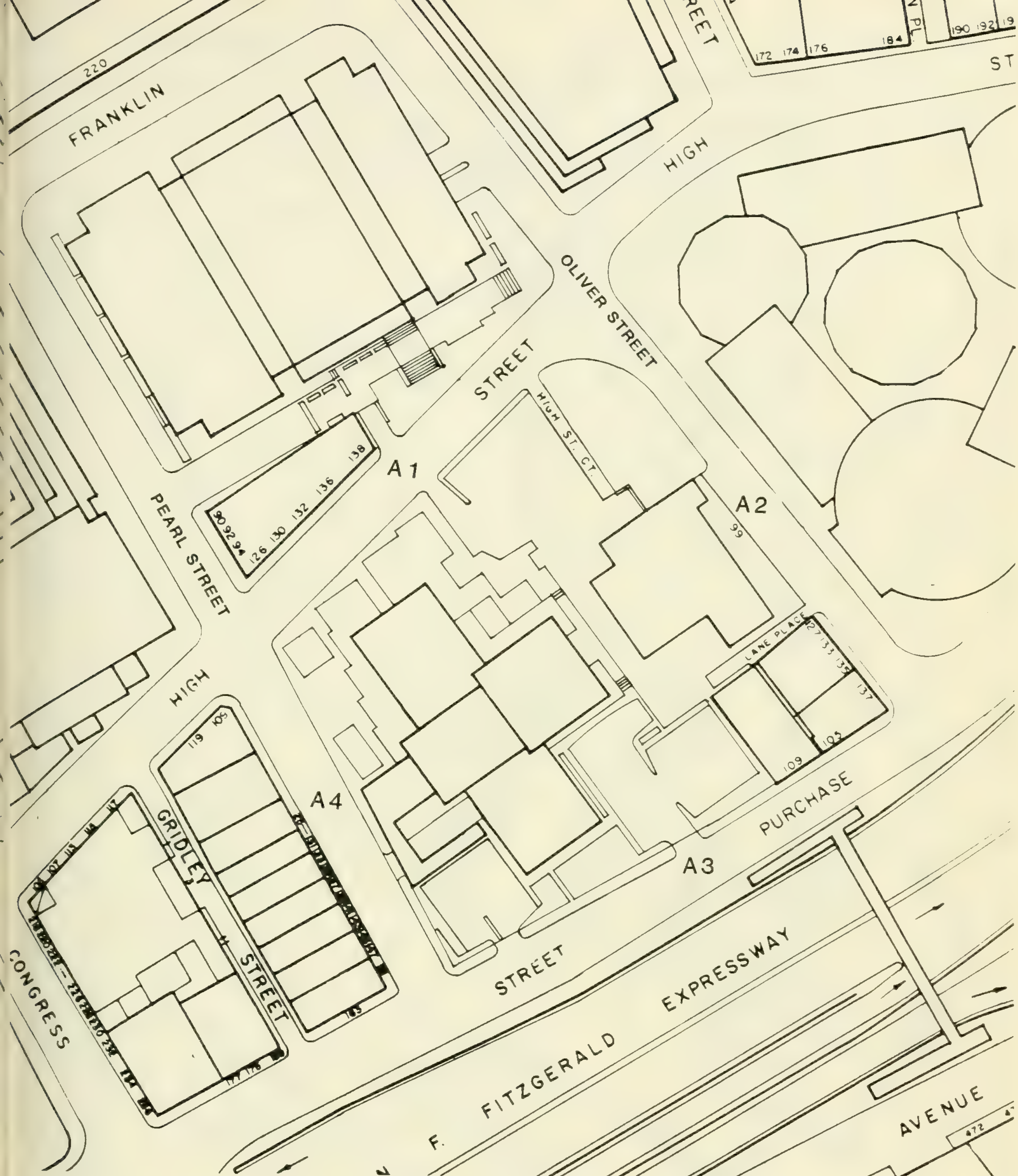


FIGURE 6.4-2 EXISTING PROJECT SITE AND DAYLIGHT STUDY OBSERVATION POINTS

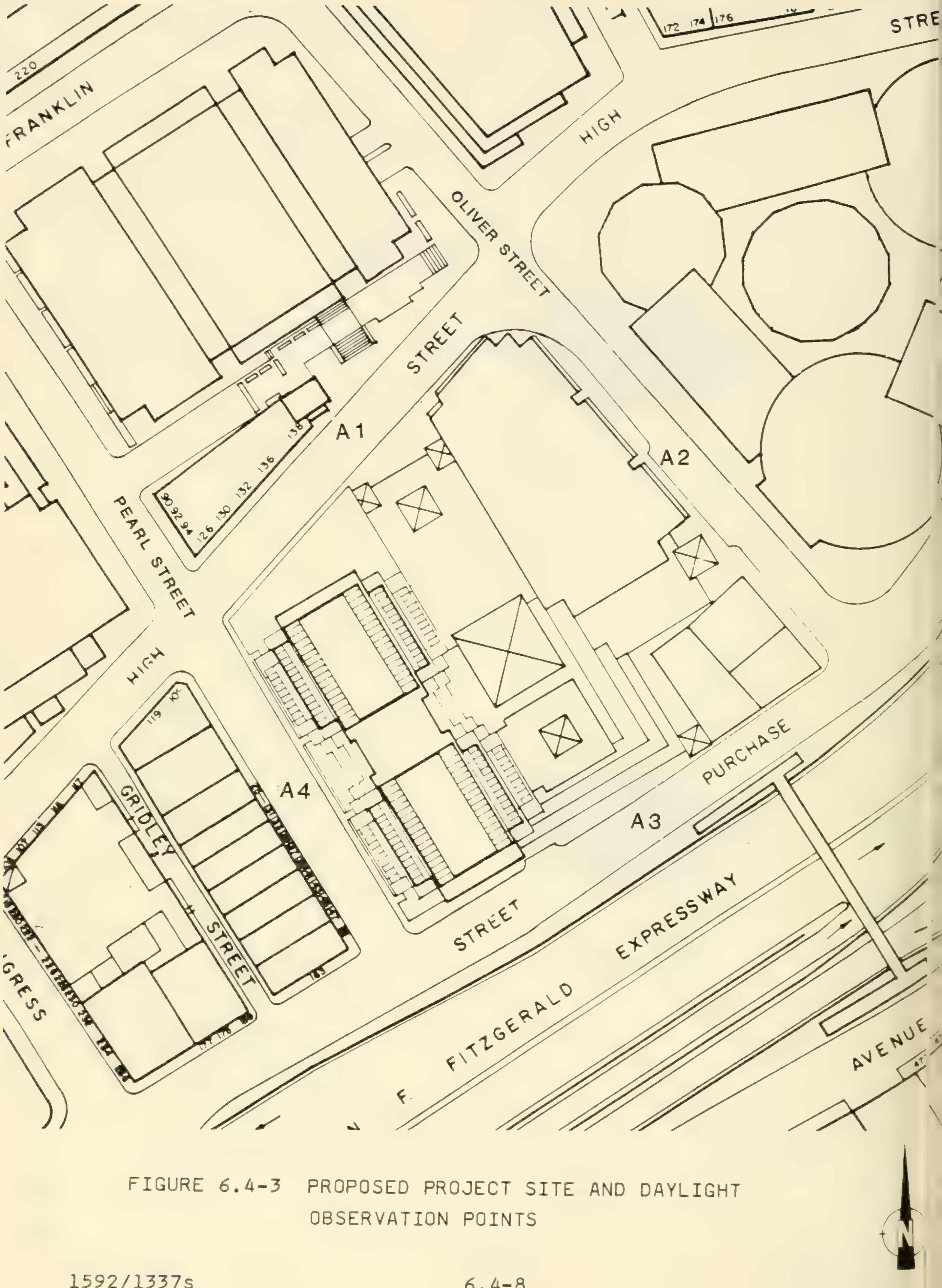


FIGURE 6.4-3 PROPOSED PROJECT SITE AND DAYLIGHT OBSERVATION POINTS

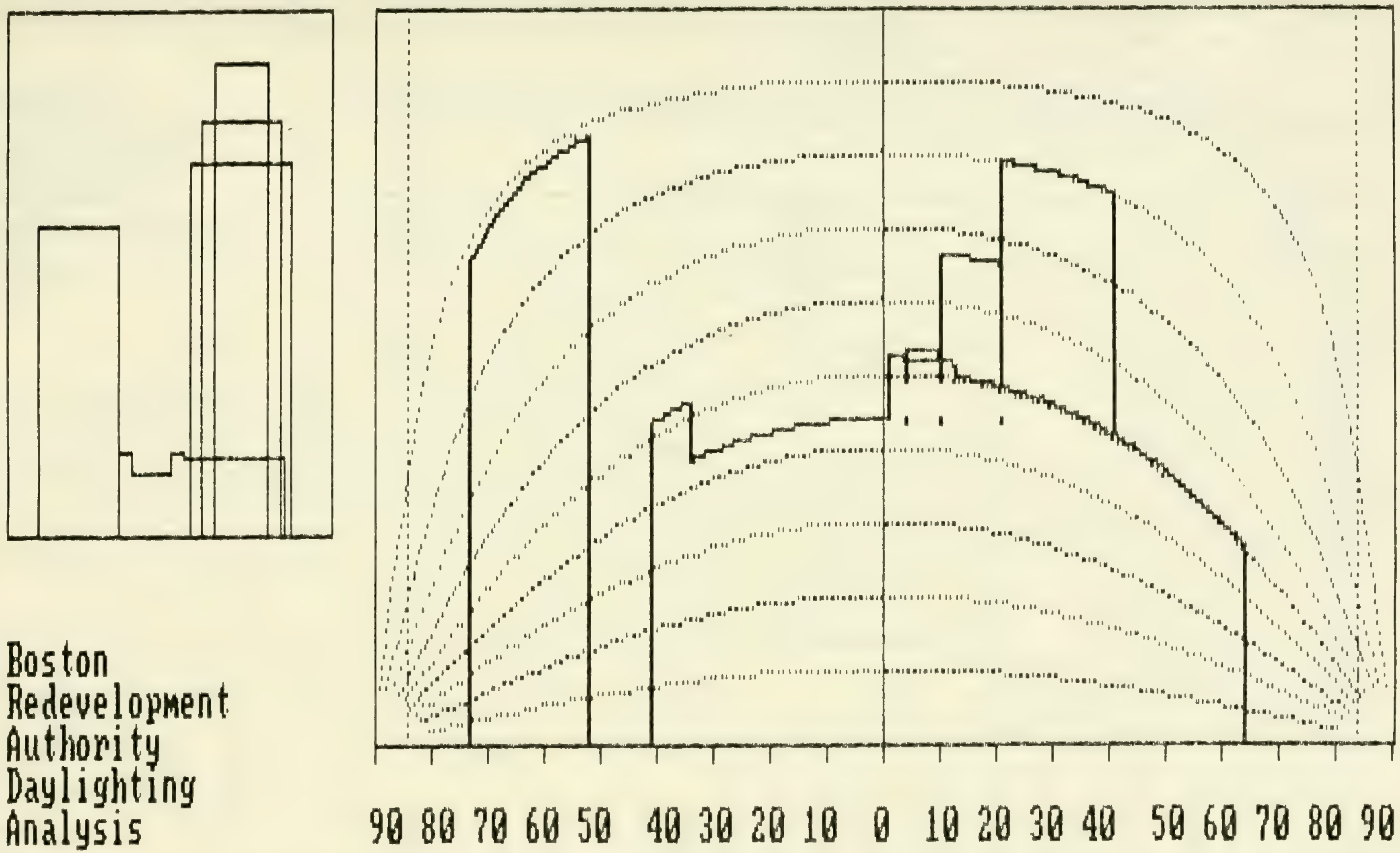


FIGURE 6.4-4 PROPOSED CONFIGURATION: HIGH STREET VIEW

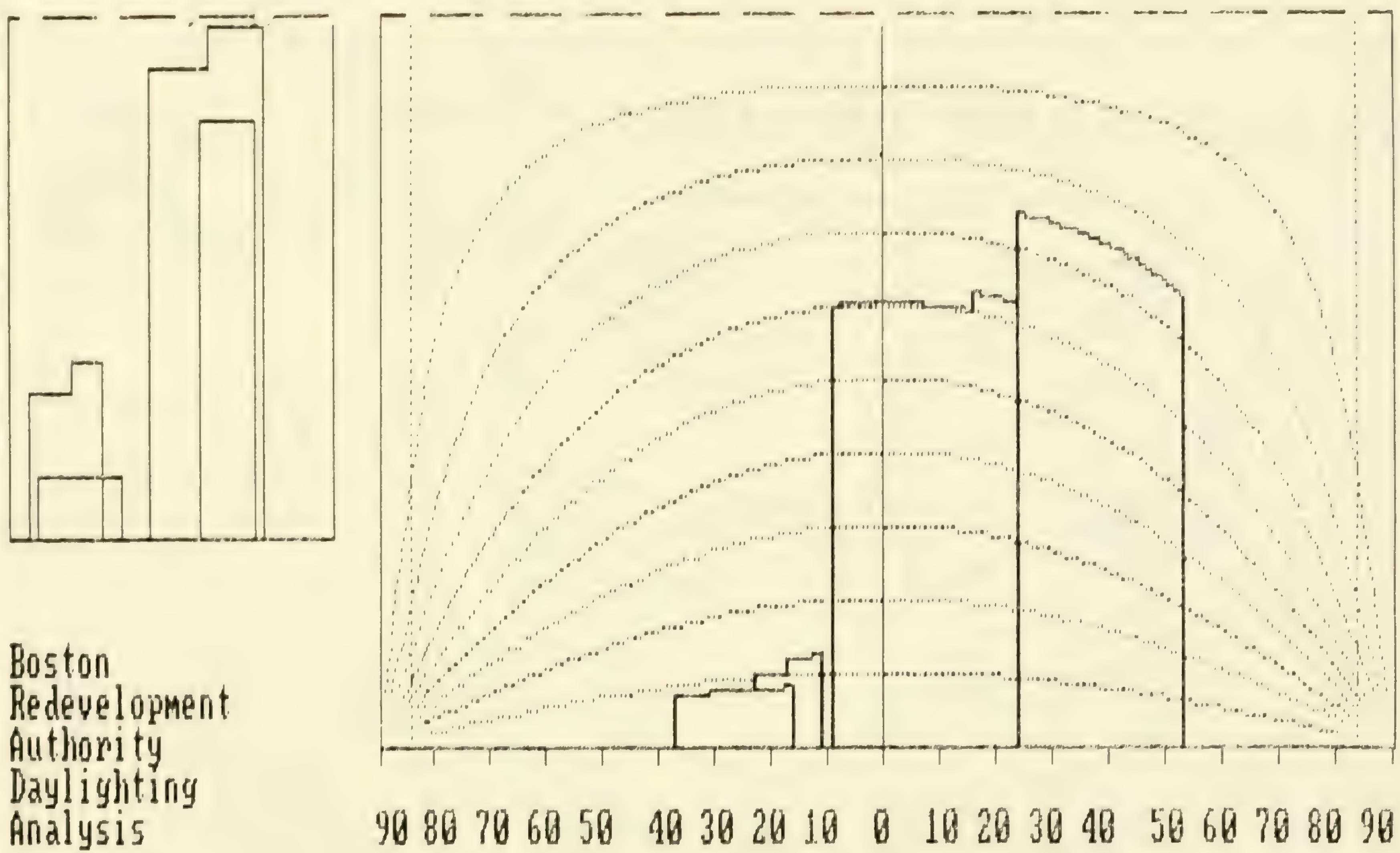


FIGURE 6.4-5 EXISTING CONFIGURATION: HIGH STREET VIEW

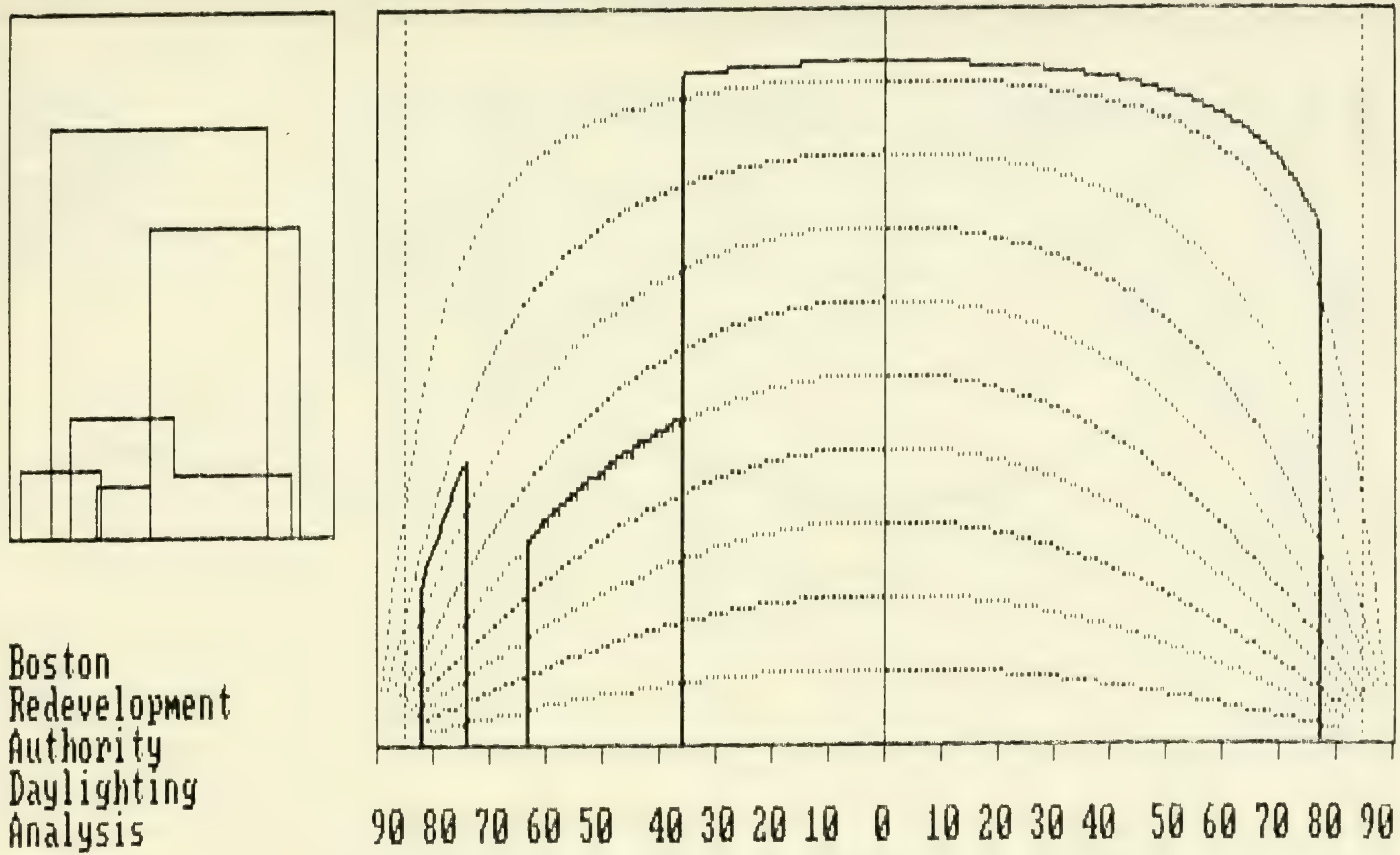


FIGURE 6.4-6 PROPOSED CONFIGURATION: OLIVER STREET VIEW

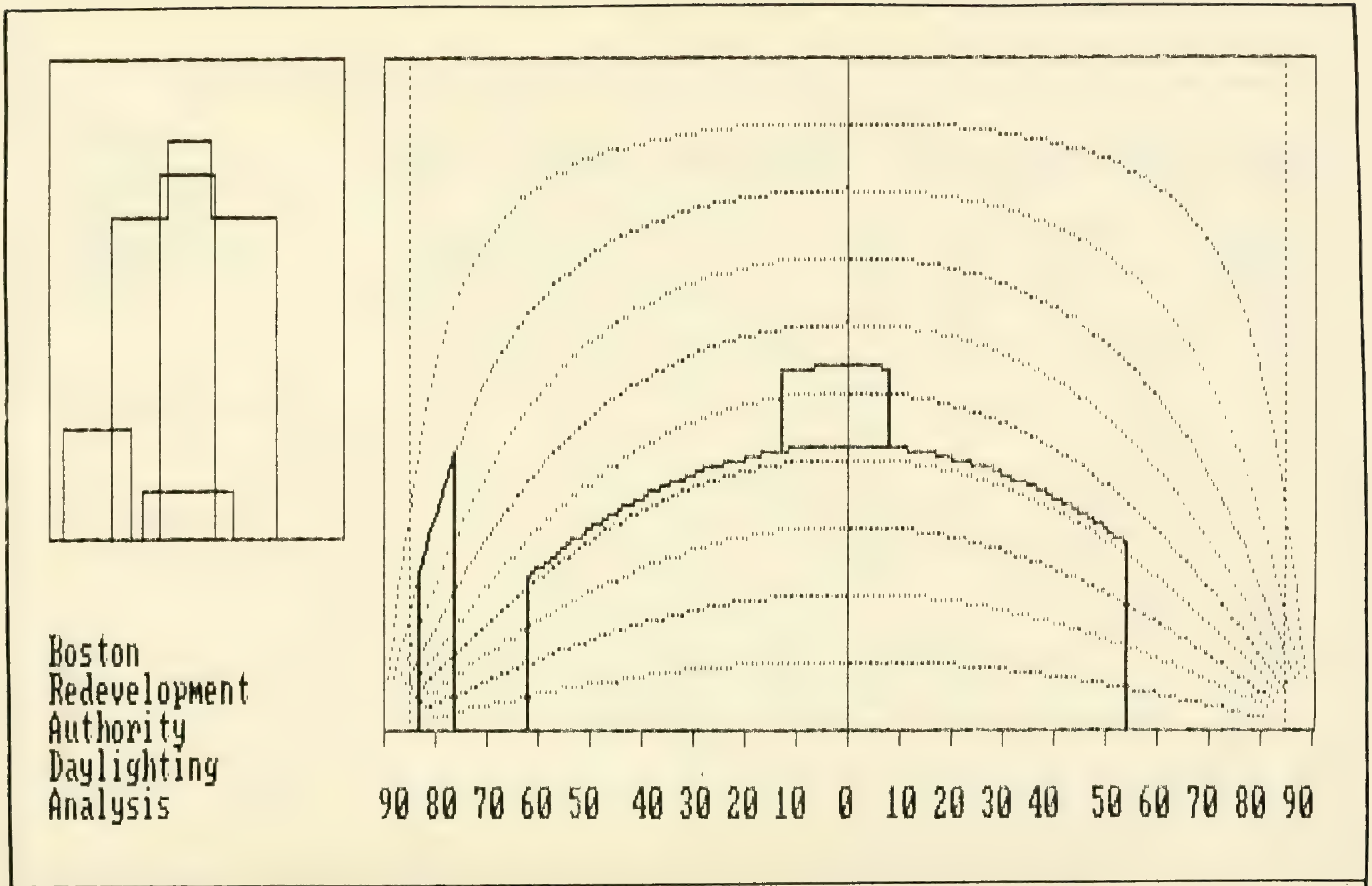


FIGURE 6.4-7 EXISTING CONFIGURATION: OLIVER STREET VIEW

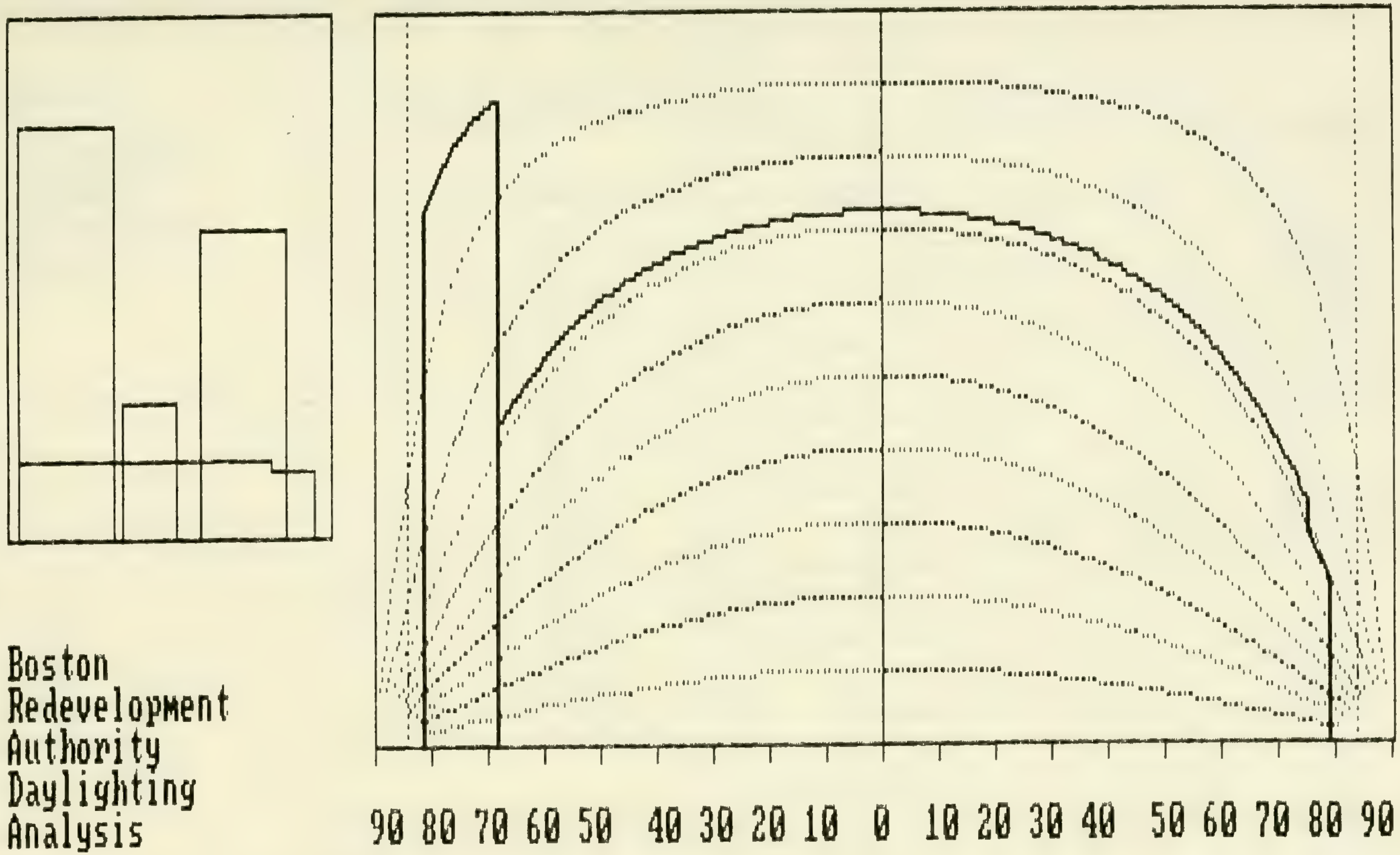


FIGURE 6.4-8 PROPOSED CONFIGURATION: PURCHASE STREET VIEW

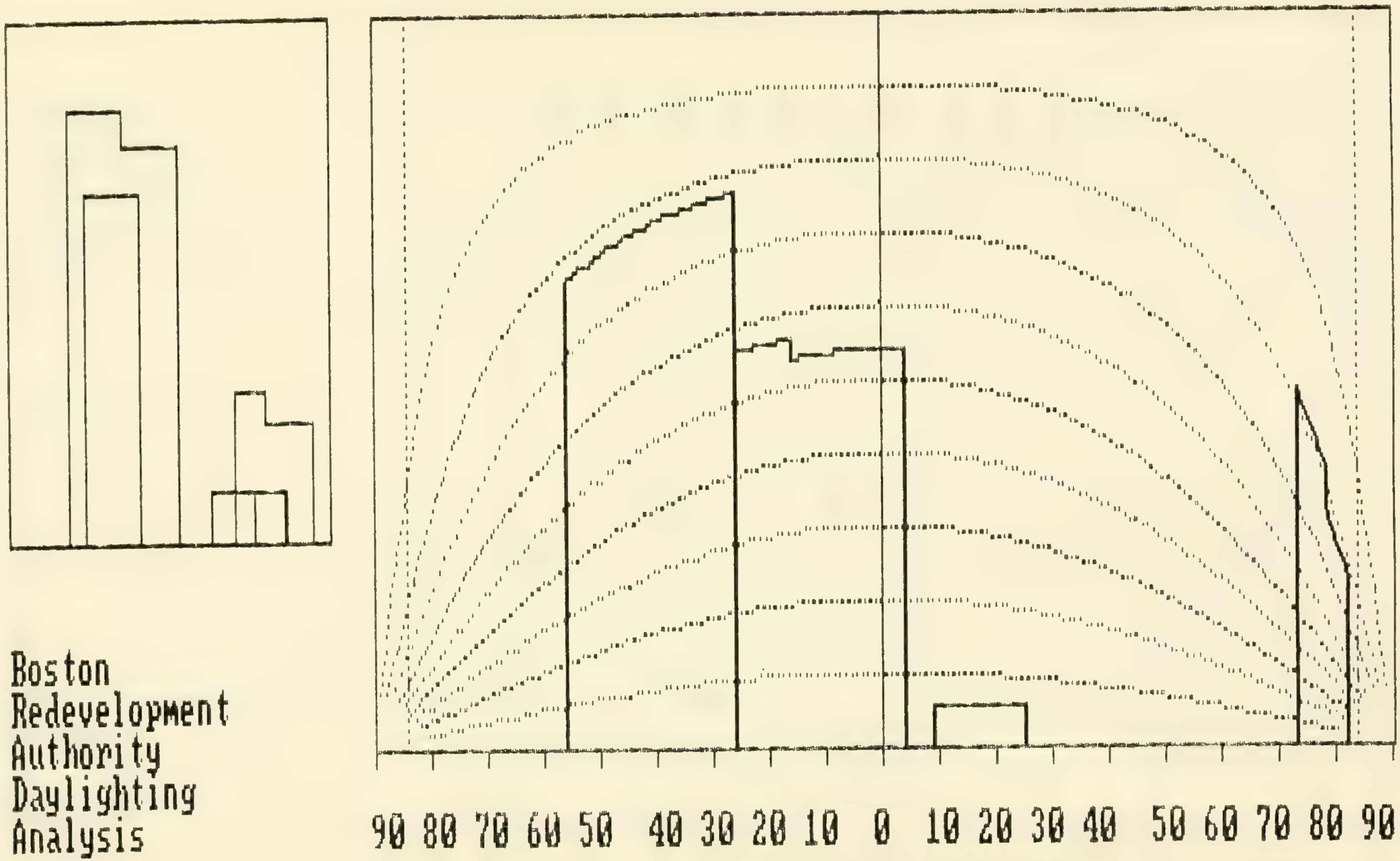


FIGURE 6.4-9 EXISTING CONFIGURATION: PURCHASE STREET VIEW

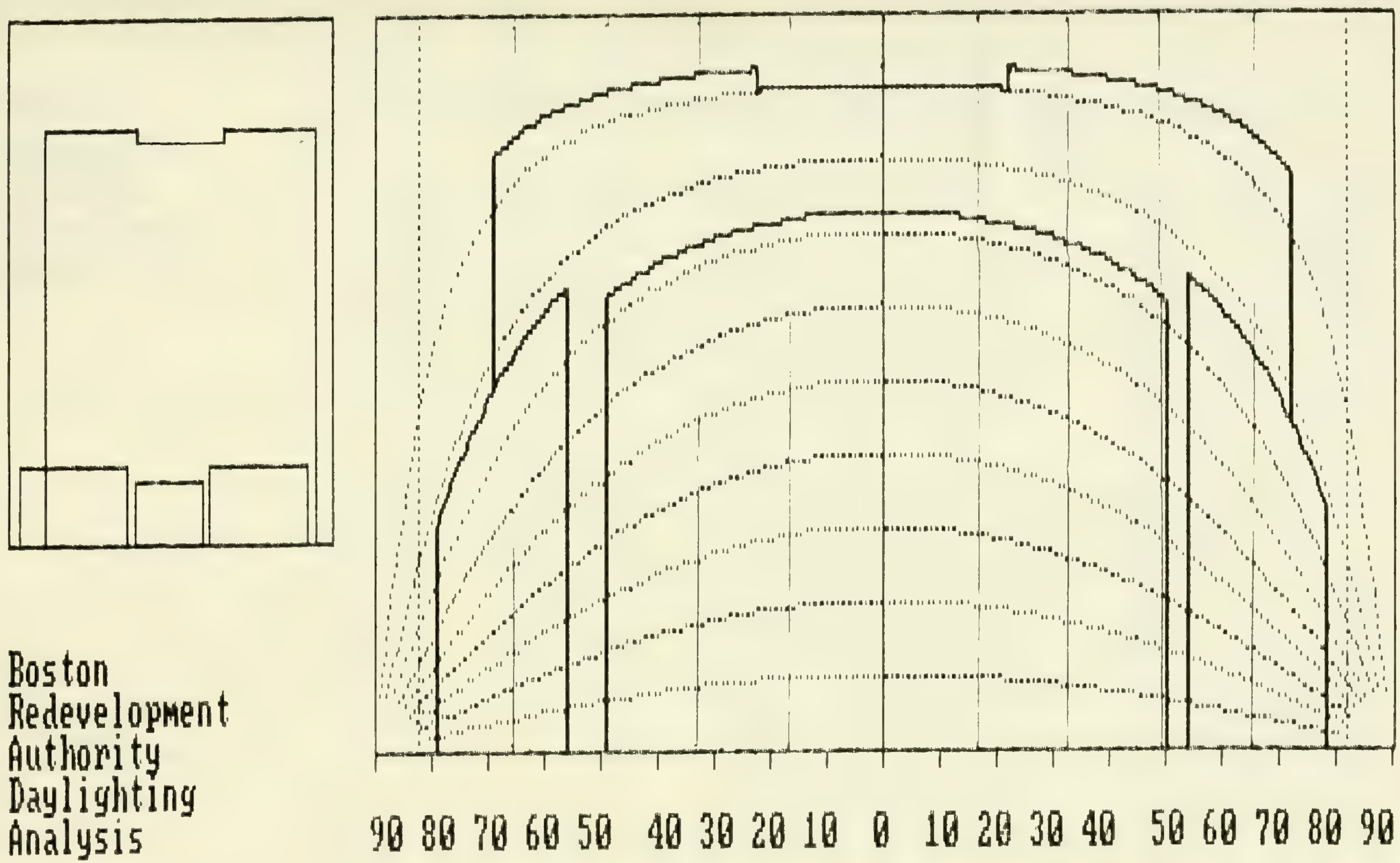


FIGURE 6.4-10 PROPOSED CONFIGURATION: PEARL STREET VIEW

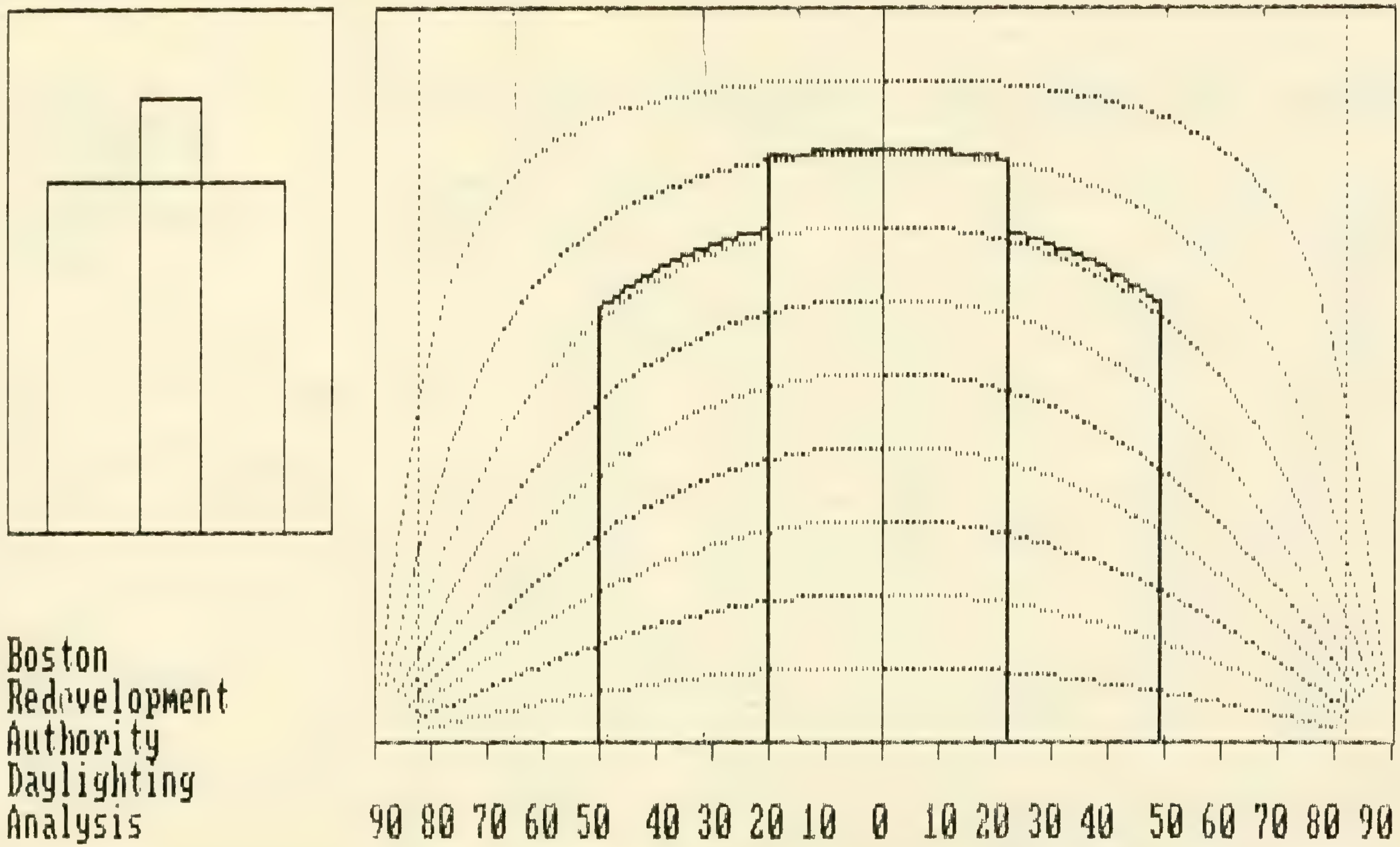


FIGURE 6.4-11 EXISTING CONFIGURATION: PEARL STREET VIEW

6.5 EXCAVATION/SOIL CONDITIONS

6.5.1 Sub-Soil Conditions

Subsurface conditions analysis and preliminary foundation design recommendations were prepared by Haley and Aldrich, Inc. in October 1984. The following is based on the information gathered to determine existing site conditions and subsurface conditions. Elevations referenced herein are Boston City Base.

Site Conditions

Site Description -- The study site is bounded by Purchase, Oliver, High, and Pearl Streets in Boston's financial district. Currently, the site is occupied by the 16-story Travelers Building, a two-story City of Boston fire station, and three vacant connected four- to six-story brick buildings formerly used for manufacturing purposes. A City-owned vacant lot, containing approximately 1,400 SF, occupies the northeast corner of the site.

Topographically, the site slopes downward slightly from west to east with grades ranging from about El. 33 near the intersection of Pearl and High Streets to El. 24 near the intersection of Purchase and Oliver Streets.

Across Purchase Street from the site is the Central Artery entrance ramp to the South Station Tunnel. The remainder of the site is surrounded by buildings ranging from four to more than 40 stories in height.

Subsurface Conditions

Previous Subsurface Explorations -- Available data on subsurface conditions and groundwater levels at and near the site have been assembled. Records of 48 test borings, 9 groundwater observation wells, and 4 groundwater piezometers were gathered from Haley & Aldrich files for projects on and around the study site. In addition, test boring information from the 1961 and 1969 editions of "Boring Data from Greater Boston", published by the Boston Society of Civil Engineers, was reviewed.

Approximate locations of test borings from Haley & Aldrich records are shown on the attached Test Boring Location Plan, Figure 6.5-1. The plan lists ground surface elevations for the test boring locations at the time of drilling. These elevations may not represent existing ground surface elevations.

Soil and Rock Conditions -- The subsurface exploration data indicate that the site is characterized by a relatively thin layer of miscellaneous fill overlaying glacial till. The fill thickness on the site varies from 0 feet up to about 15 feet and is generally medium compact to compact in density. Glacial deposits below the fill are as thick as 125 feet and generally described as very dense. These soils are either glacial till or glaciomarine soils, depending on the apparent mode and environment of deposition. The glacial deposits directly overlie the Cambridge Argillite bedrock in the site area. Based on available information, the bedrock is between 100 and 150 feet below ground surface. A subsurface profile through the site is shown on Figure 6.5-2.

- ● Boring location
  OW—Groundwater observation well
  PZ—Groundwater piezometer
- ┈ Outline of estimated Colonial Boston Shoreline
- ↲ Location and orientation of subsurface profile, Figure 2

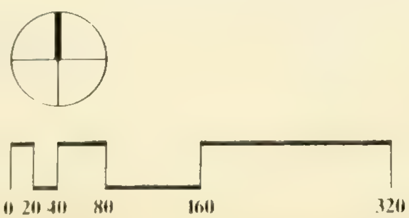
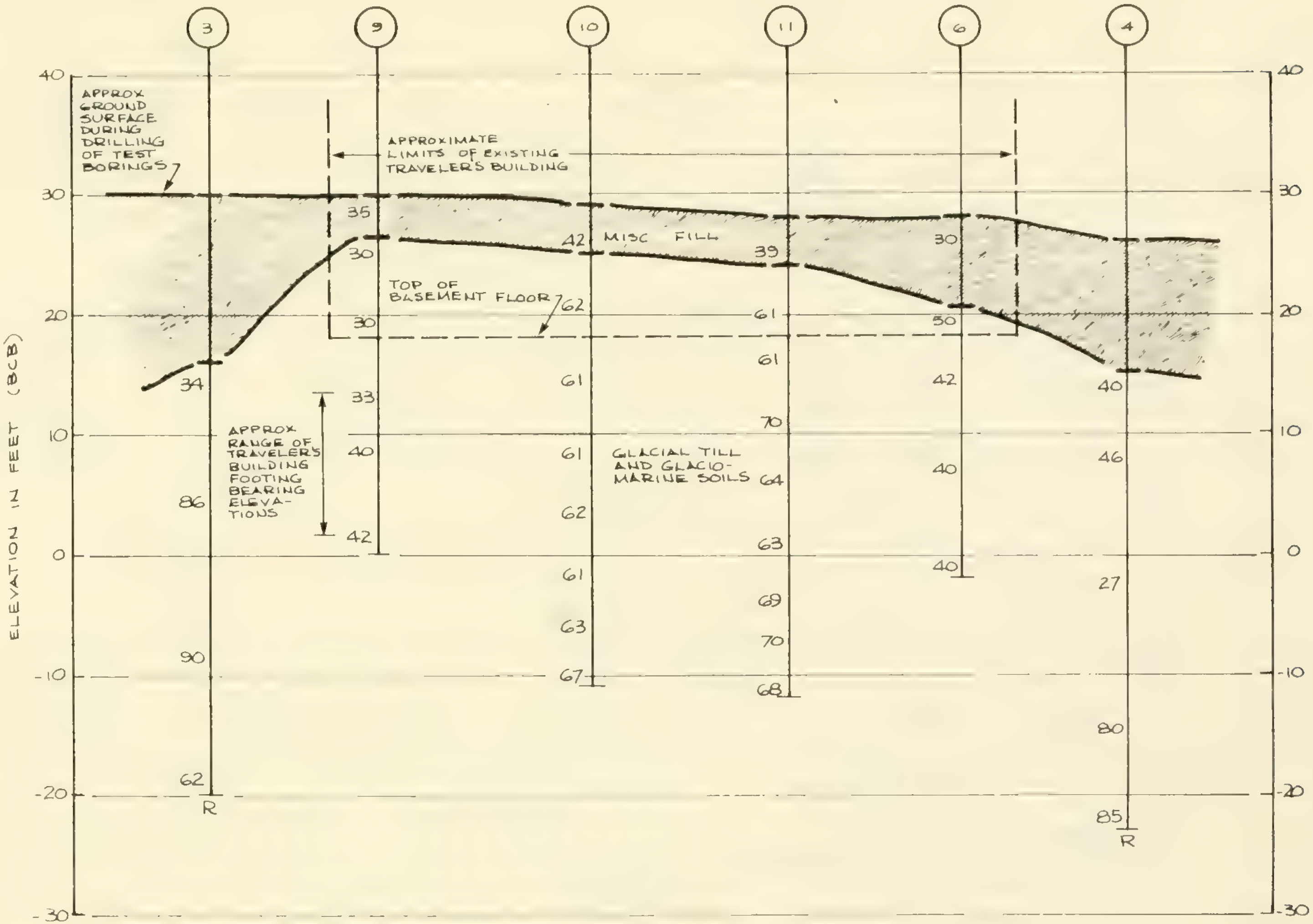


FIGURE 6.5-1 TEST BORING LOCATION PLAN



LEGEND

(3)	TEST BORING DESIGNATION AND LOCATION
	APPROXIMATE GROUND SURFACE ELEVATION DURING DRILLING OF TEST BORING
	APPROXIMATE TOP OF NATURAL INORGANIC GLACIAL SOIL DEPOSITS
34	NUMBER OF BLOWS WITH A 140 LB. HAMMER FALLING 30 IN. TO ADVANCE THE 2 IN. DIA. SAMPLING PIPE ONE FOOT.
	BOTTOM OF TEST BORING
R	INDICATES "REFUSAL". TEST BORING COULD NOT BE ADVANCED FURTHER WITH AVAILABLE EQUIPMENT

NOTES

1. TEST BORING CONDUCTED DURING 1955 AND 1957 BY RAYMOND CONCRETE PILE CO.
2. PROFILE IS FOR ILLUSTRATIVE PURPOSES ONLY. ACTUAL SUBSURFACE CONDITIONS AND EXISTING GROUND SURFACE MAY VARY FROM THOSE SHOWN.
3. REFER TO REPORT TEXT FOR DISCUSSION OF SUBSURFACE SOIL AND GROUNDWATER CONDITIONS
4. REFER TO FIGURE 1 FOR LOCATION AND ORIENTATION OF SUBSURFACE PROFILE A A IN PLAN

FIGURE 6.5-2 SUBSURFACE PROFILE

The location of the original shoreline during colonial times was investigated using subsurface data in the site vicinity. It appears that the project site is located inside the colonial shoreline.

Groundwater Levels -- There is evidence of two groundwater levels in the site vicinity. Typically, groundwater levels measured by piezometers and observation wells near the site have varied between El. 3 and 9 or from 15 to 30 feet below site ground elevations. These levels are within the range of Boston Harbor tidal fluctuations between about El. 1 and 10.5 but do not appear to vary with the tide. Water levels between El. 14 and 23 (between about 1 and 19 feet below site ground elevations) have been measured in several nearby shallow observation wells. These levels indicate the possibility of a perched groundwater level in the fill near the site. A design groundwater level of El. 23 will be assumed for planning considerations.

6.5.2 Excavation and Foundation Construction - Potential Impacts

The existing miscellaneous fills are not suitable to support building foundations. Proposed buildings will be founded in the glacial deposits. Foundations that are considered technically and economically feasible for building support are footings or mats. Footings are generally most economical for lighter loads. When column loads become large enough that the combined areas of footings become greater than about 55 percent of the building area, mat foundations tend to become more economical.

Excavation Method

Blasting at One Twenty Five High Street will not be necessary. Any rock outcropping will be mechanically removed. No continuous pile driving will take place at the site. The foundation will be on soldier piles which will be pre-drilled rather than driven.

Based on expected soil and groundwater conditions, deep excavations (60 feet or more) at the study site may be considered. Lateral earth support would likely be best accomplished by a system of steel soldier piles and wood lagging with external bracing consisting of tiebacks drilled and grouted into the glacial till. Installation of steel sheet piling would be nearly impossible through the glacial soils.

Dewatering

A soldier pile and lagging system will allow seepage into the excavation during construction. In addition, seepage will occur upward through the excavation bottom. Glacial soils are generally rather impervious; thus, the volume of water seeping into the excavation should be small enough for removal by open pumping. However, significant pervious zones may be encountered during excavation in the glacial till. Such zones may require dewatering or grouting before the excavation can proceed deeper.

Hydrostatic Design

In order to provide uplift resistance to hydrostatic pressure, a building must have sufficient weight (height) for various excavation depths. For example, a building with lowest floor slab bearing 60 feet below ground surface at the study site should be at least 30 stories tall above grade to have

sufficient weight to resist hydrostatic pressures. Otherwise, a permanent underdrain system may be used below the lowest floor slab. However, such an underdrain system must be designed so that the groundwater levels are not lowered in the surrounding areas.

Potential for Ground Movement

Based on evaluation of available data, the glacial soils at the study site are considered capable of supporting structures up to 50 stories in height on shallow footings or mat foundations. Structure settlements will result primarily from elastic deformations of the foundation/soil system and would be expected to occur mostly during construction as loads are applied. No significant post-construction settlement is expected and differential settlements should be small.

Impact on Adjacent Buildings

Construction of the project will be in one continuous phase, including maintaining some of the existing buildings until after a portion of the development has been completed (such as the fire station). It is important to note that construction adjacent to existing buildings, particularly construction of multiple basements, could adversely affect the existing buildings. Structures remaining on-site will require special support techniques to insure their uninterrupted service during and after construction. Depending on desired excavation depths, a maximum excavation slope steepness of 1:1 adjacent to buildings will be required; it may be necessary to underpin the existing buildings.

6.6 AIR QUALITY

6.6.1 Objective

The objective of this analysis is to verify that, with construction of One Twenty Five High Street, the Massachusetts and National Ambient Air Quality Standards (NAAQS) for carbon monoxide (CO) will be attained and maintained. The standards, established by the Federal Clean Air Act, are designed to protect public health and welfare. To demonstrate compliance, it is necessary to identify those areas of human activity (sensitive receptors) exposed to maximum air pollutant levels from motor vehicle emissions in the project area. Using air quality modeling techniques, CO levels are estimated at these sensitive receptors for the existing conditions, anticipated No-Build conditions, and the project alternatives. Comparison of projected pollutant levels to the NAAQS permits evaluation of whether motor vehicle emissions associated with the project will pose a threat to public health or welfare.

6.6.2 Pollutant Sources and Effects

Of the six pollutants regulated by the NAAQS, four are emitted by motor vehicles or formed from their emissions: CO, nitrogen oxides (NO_x), ozone (O_3), and lead (Pb). CO is used in this analysis as an indicator of roadway air pollution levels, since it is the most abundant and persistent pollutant emitted by motor vehicles. Further, its nonreactive properties over the short term allow pollutant transport and dispersion to be modeled.

The adverse health effects of CO are a result of its combination with blood hemoglobin to form carboxyhemoglobin (COHb). As CO replaces oxygen in the red blood cells this compound reduces the amount of oxygen which can be transported from the lungs to the body tissues. The presence of relatively small amounts of CO results in significant interference with essential cardiovascular-respiratory functions. Relatively brief exposure to levels over 40 parts per million (ppm) can impair perception, discrimination, and other psychomotor functions.

National Ambient Air Quality Standards (NAAQS) for CO have been set by the U.S. Environmental Protection Agency (EPA). Standards for the Commonwealth of Massachusetts are identical to the Federal standards. The target date for attainment of national primary standards in Massachusetts is December 31, 1987. The primary CO standards set a maximum concentration of 35 ppm for a one-hour period, and 9 ppm for eight hours, each not to be exceeded more than once per year.

6.6.3 Background Air Quality

Any microscale analysis requires an estimate of "background" air quality levels. Background levels reflect the contribution of all sources in the project area less the specific intersections analyzed. Currently the Massachusetts Department of Environmental Quality Engineering (DEQE), Division of Air Quality Control maintains a CO monitoring station along Essex Street in downtown Boston. Based on data collected at this monitoring location, background levels of 6.0 ppm (1-Hour) and 3.6 ppm (8-Hour) have been recommended* for One Twenty Five High Street.

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* Personal Communication, Mr. Richard Mertens, Boston Redevelopment Authority (BRA), November 13, 1986

6.6.4 Study Approach

The One Twenty Five High Street air quality analysis was based on BRA* and DEQE recommended procedures. The analysis calculated maximum one-hour and eight-hour CO concentrations at sensitive receptors located adjacent to five key intersections in the project area for the following three cases:

Case No.	Year	Project Alternative
1	1986	Existing
2	1994	No-Build
3	1994	Build

For each case, the EPA MOBILE3** and FHWA CALINE3*** computer programs were used to calculate motor vehicle emissions and CO concentrations at intersections. Emission calculations, which are detailed in Appendix C, used the MOBILE3 national cold/hot start mix default values for the peak eight-hour period while a higher cold start mix was utilized for the peak one-hour period. In addition, the analysis incorporated the effects of the Commonwealth's statewide inspection and maintenance (I&M) program. These emissions data were used as input to the CALINE3 model, adapted for intersection analysis,**** to predict CO concentrations. CALINE3 modeling and assumptions are presented in Appendix C. An additional analysis was performed to determine impacts of the project's six-level underground parking garage. This analysis utilized the EPA MOBILE3 and EPA Indirect Source

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* Personal Communication, Mr. Richard Mertens, Boston Redevelopment Authority (BRA), November 14, 1986.

** EPA, User's Guide to MOBILE3: Mobile Source Emissions Model, EPA-460/3-84-002, Ann Arbor, MI, June 1984.

*** FHWA, CALINE3 - A Versatile Dispersion Model for Predicting Air Pollutant Levels Near Highways and Arterial Streets, FHWA/CA/TL-79/23, November, 1979.

**** EPA Region I, Region I Mobile Source Modeling Procedures, January 1, 1985.

Guidelines* technique to calculate emission rates of the proposed garage's ventilation system while Halitsky's gas diffusion equation was used to calculate CO impacts at the same receptors studied in the intersection analysis. This methodology is also detailed in Appendix C.

The air quality analysis examined CO levels at the following five intersections within the study area:

- Purchase Street/Congress Street
- Atlantic Avenue/Congress Street
- Atlantic Avenue/Surface Artery/High Street
- Atlantic Avenue/Northern Avenue
- Purchase Street/Oliver Street

These were selected in cooperation with the BRA and represent locations (except for Purchase and Oliver Streets) where the project results in degradation of traffic for intersections operating at or below levels-of-service (LOS) D. The intersection of Purchase and Oliver Streets was selected based solely on peak AM traffic increases. The study used peak one-hour traffic volumes at each intersection for the design day. The peak PM hour was selected for the Purchase Street/ Congress Street and Atlantic/Congress Street intersections. For the three remaining intersections, the peak AM hour was used. Traffic volumes for the peak eight-hour period at each intersection were calculated by multiplying peak one-hour traffic volumes with a peak one-hour to peak eight-hour conversion factor. These factors are based on traffic counts in and around the project area and provide an hourly average volume for the peak eight-hour period at each approach of each intersection. These data are necessary for caclulating CO concentrations for the eight-hour averaging period. At the intersection of Purchase and Congress Streets, a peak one- to eight-hour factor of 0.70

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* EPA, Guidelines for Air Quality Maintenance Planning and Analysis Volume 9, (Revised): Evaluating Indirect Sources, Second Printing, EPA-450/4-78-001, Research Triangle Park.

was used for Purchase Street and 0.68 for Congress Street.* At Purchase and Oliver Streets, factors of 0.75 and 0.58 were utilized, respectively.* For the three other intersections studied, a conservative factor of 0.82 was used based on data collected in the Dewey Square area. All traffic data utilized in the air quality analysis is summarized in the air quality analysis intersection worksheets provided in Appendix C.

Since CO emissions are greatest at roadway intersections due to vehicle idling, acceleration and deceleration, sensitive receptors in close proximity to "worst case" intersections were selected. The receptor locations were chosen to be consistent with the recommendations in EPA Guidelines** namely: 1) where maximum CO concentrations are likely to occur (i.e., adjacent to intersection vehicle queues), and 2) where the general public is likely to have access. The receptor locations at each intersection are shown in Figures 6.6-1 through 6.6-7. All intersections are signalized except for Atlantic/Northern Avenues under the existing case and Purchase/Oliver Streets. These two intersections are stop sign controlled.

6.6.5 Results

Intersection Analysis

The intersection analysis predicted maximum one-hour and eight-hour CO concentrations at sensitive receptor locations around five intersections using the FHWA CALINE3 computer program. Computer output is included in Appendix C. Intersection impacts plus background levels are summarized in Table 6.6-1.

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* International Place Final Environmental Impact Report, "Air Quality Analysis", EOEA #5199, October, 1984.

**EPA, Guidelines for Air Quality Maintenance Planning and Analysis Volume 9, (Revised): Evaluating Indirect Sources, Second Printing, EPA-450/4-78-001, Research Triangle Park.

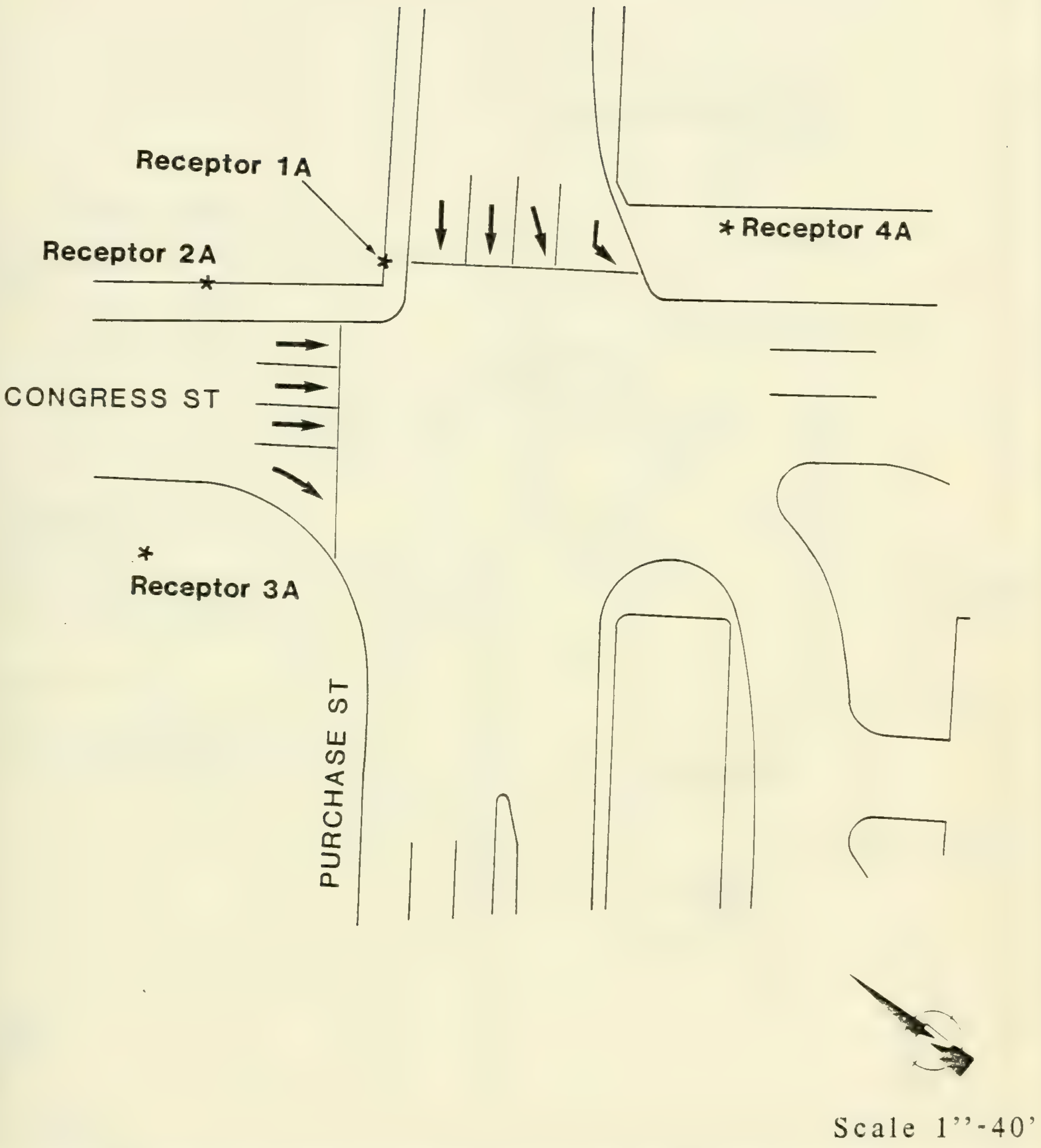

FIGURE 6.6-1 PURCHASE STREET/CONGRESS STREET

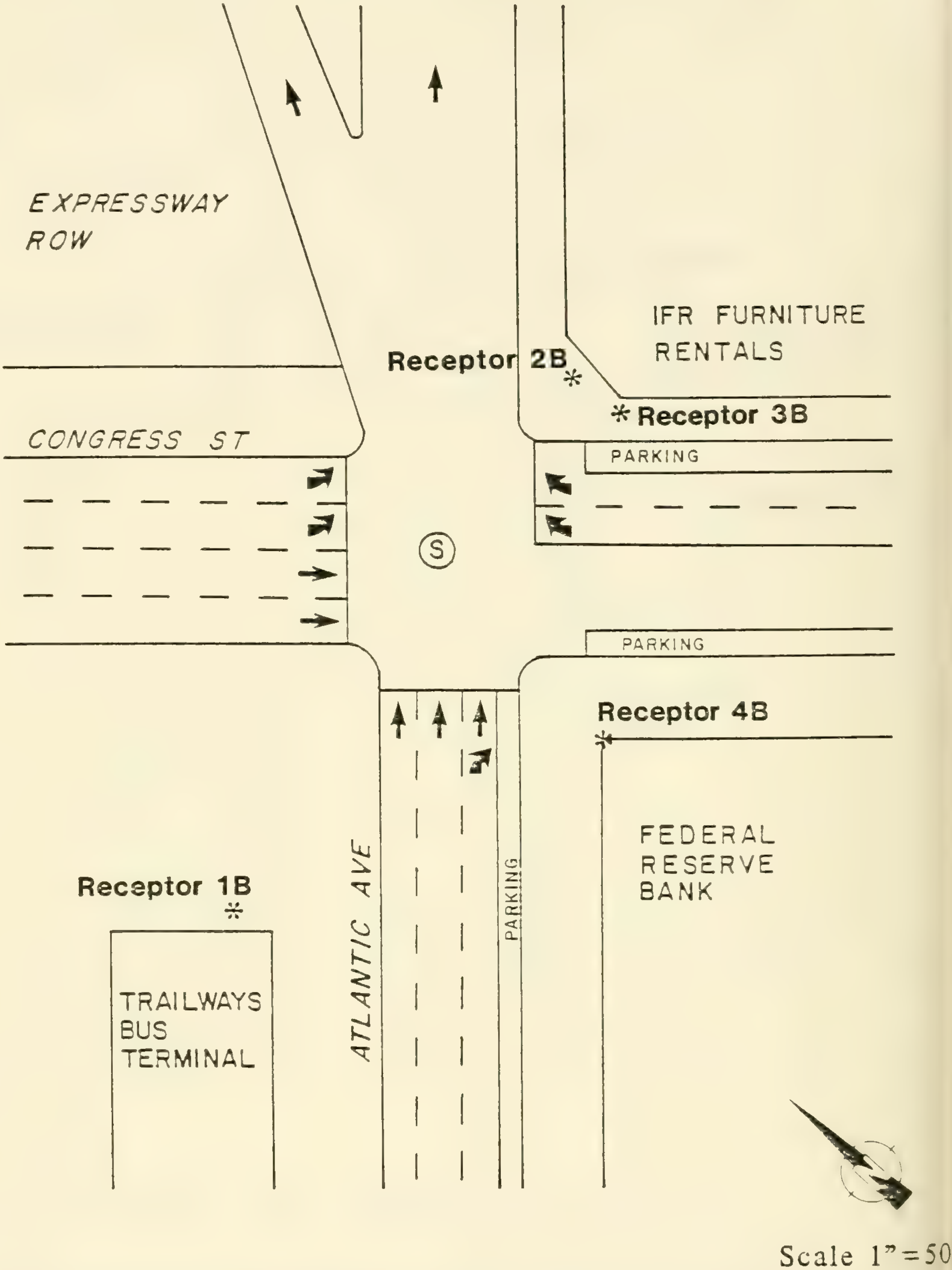

FIGURE 6.6-2 ATLANTIC AVENUE/CONGRESS STREET

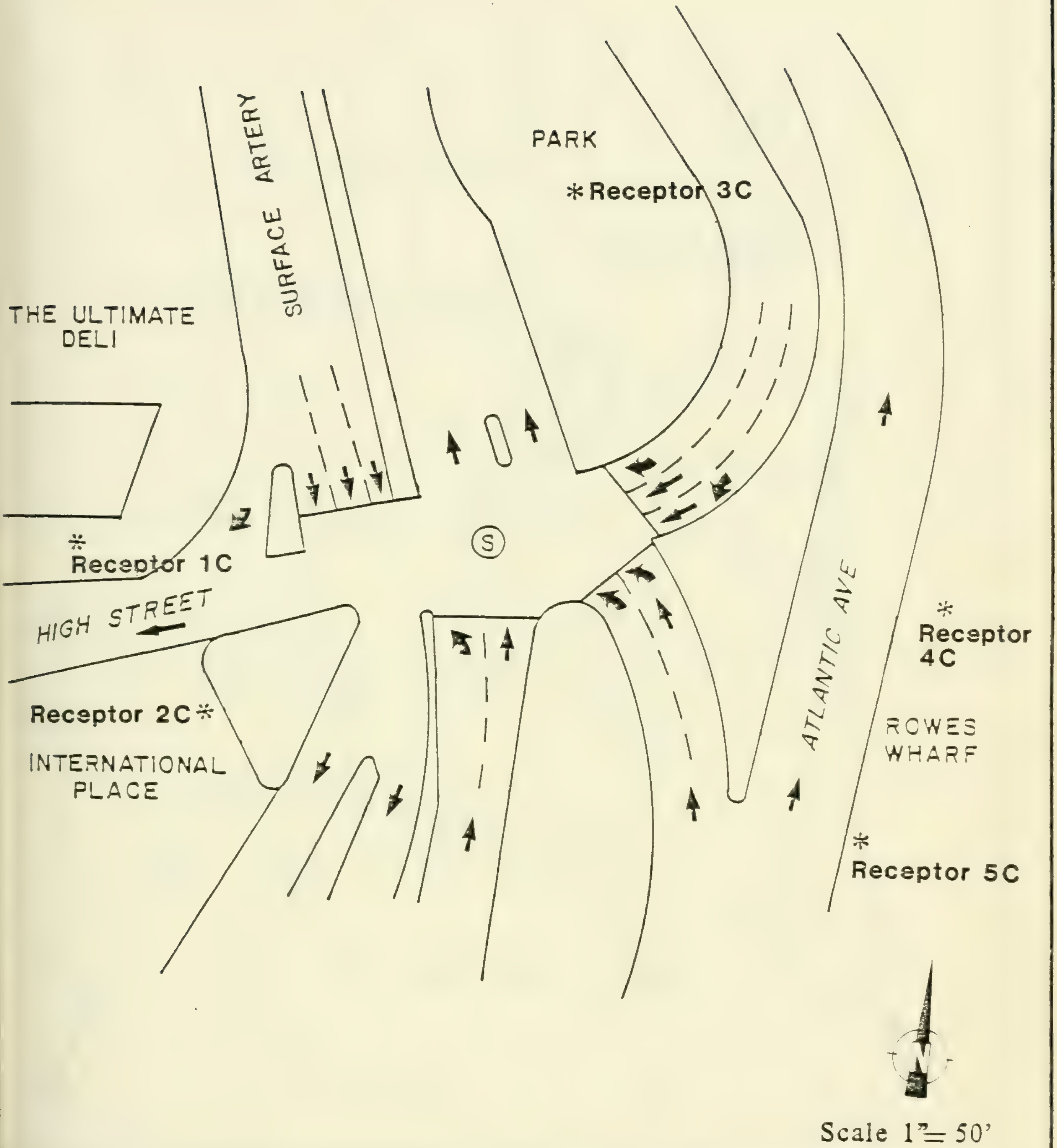

FIGURE 6.6-3 ATLANTIC AVENUE/SURFACE ARTERY/HIGH STREET

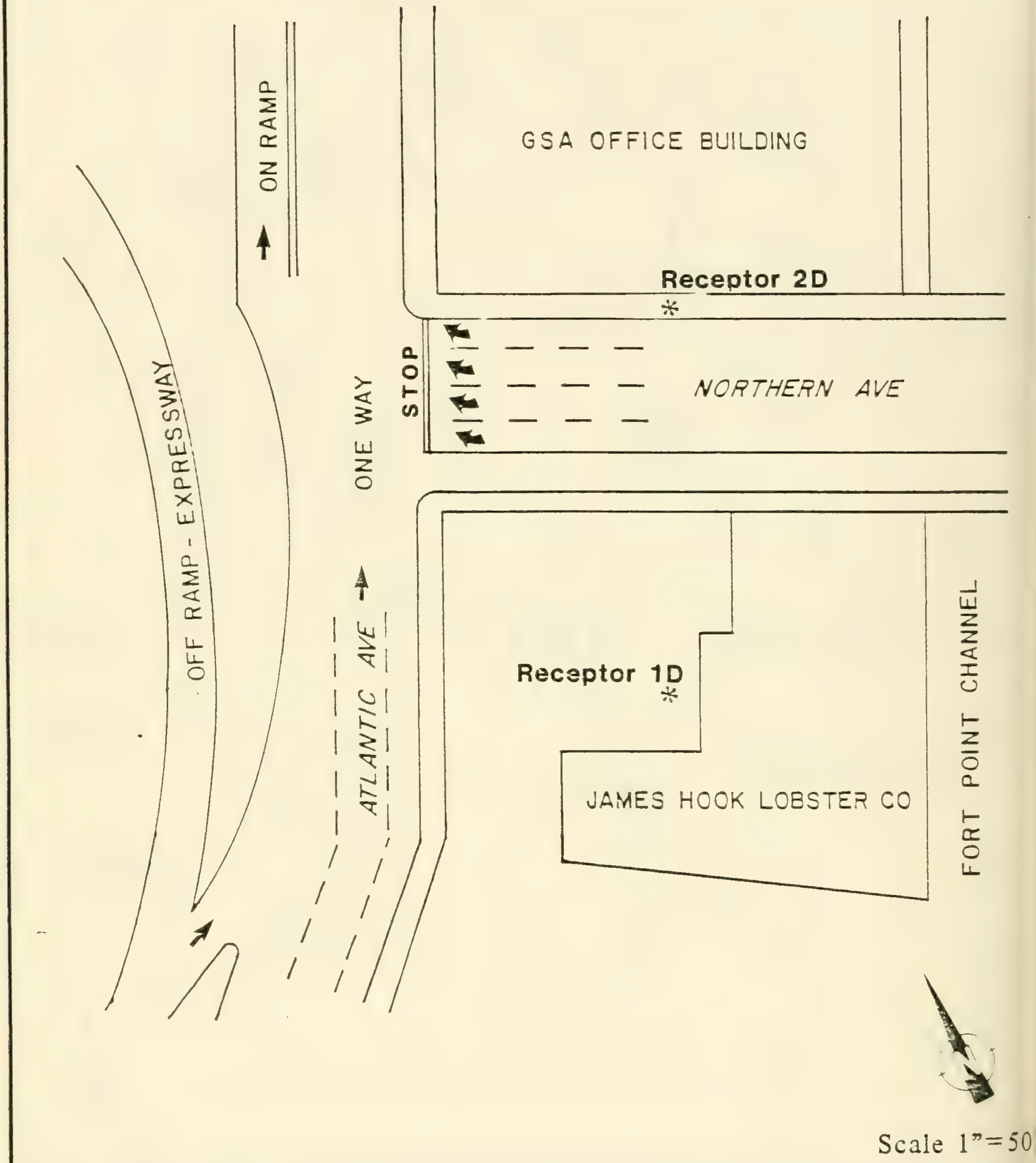

FIGURE 6.6-4 EXISTING ATLANTIC AVENUE/NORTHERN AVENUE

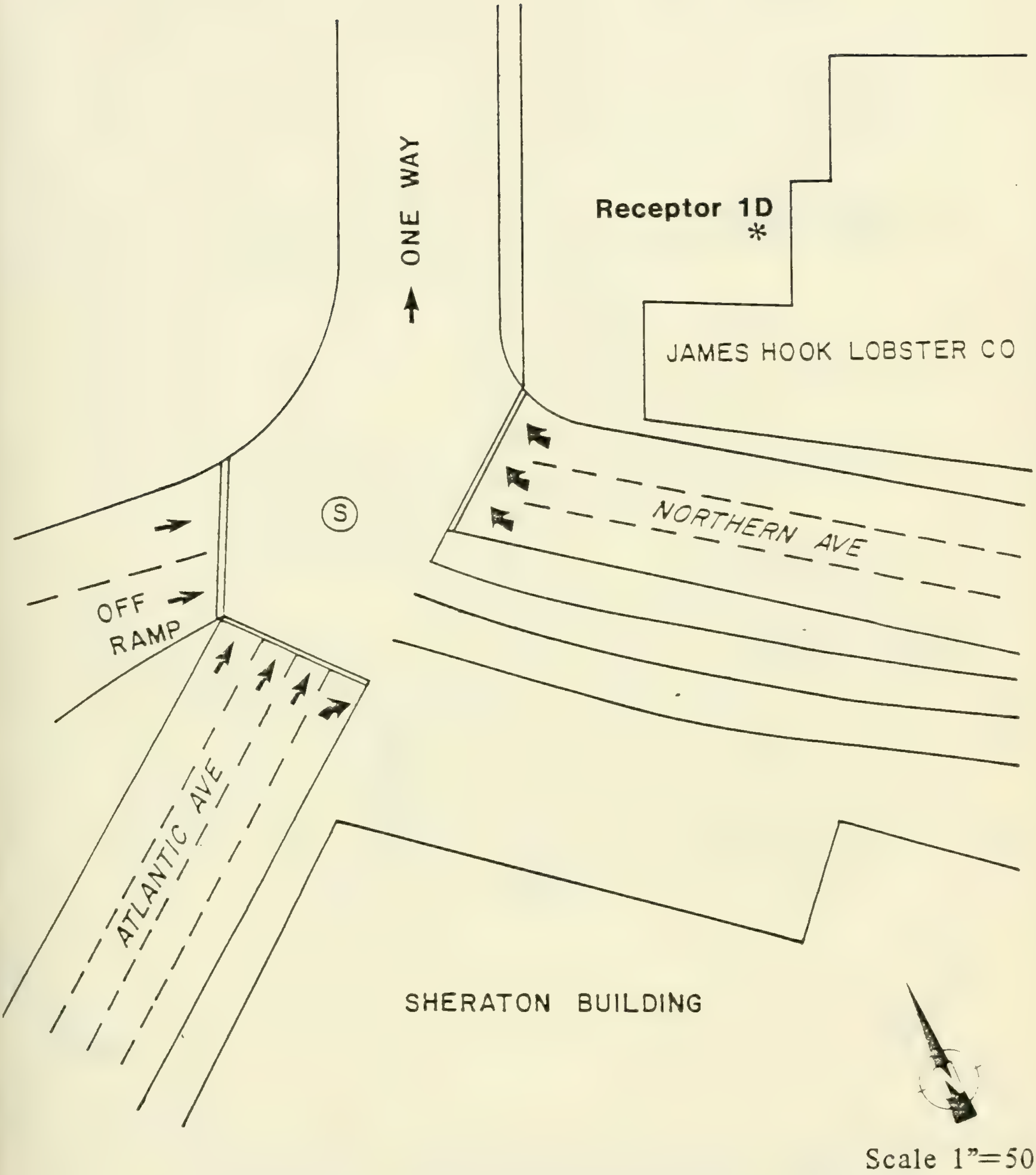

FIGURE 6.6-5 FUTURE ATLANTIC AVENUE/NORTHERN AVENUE

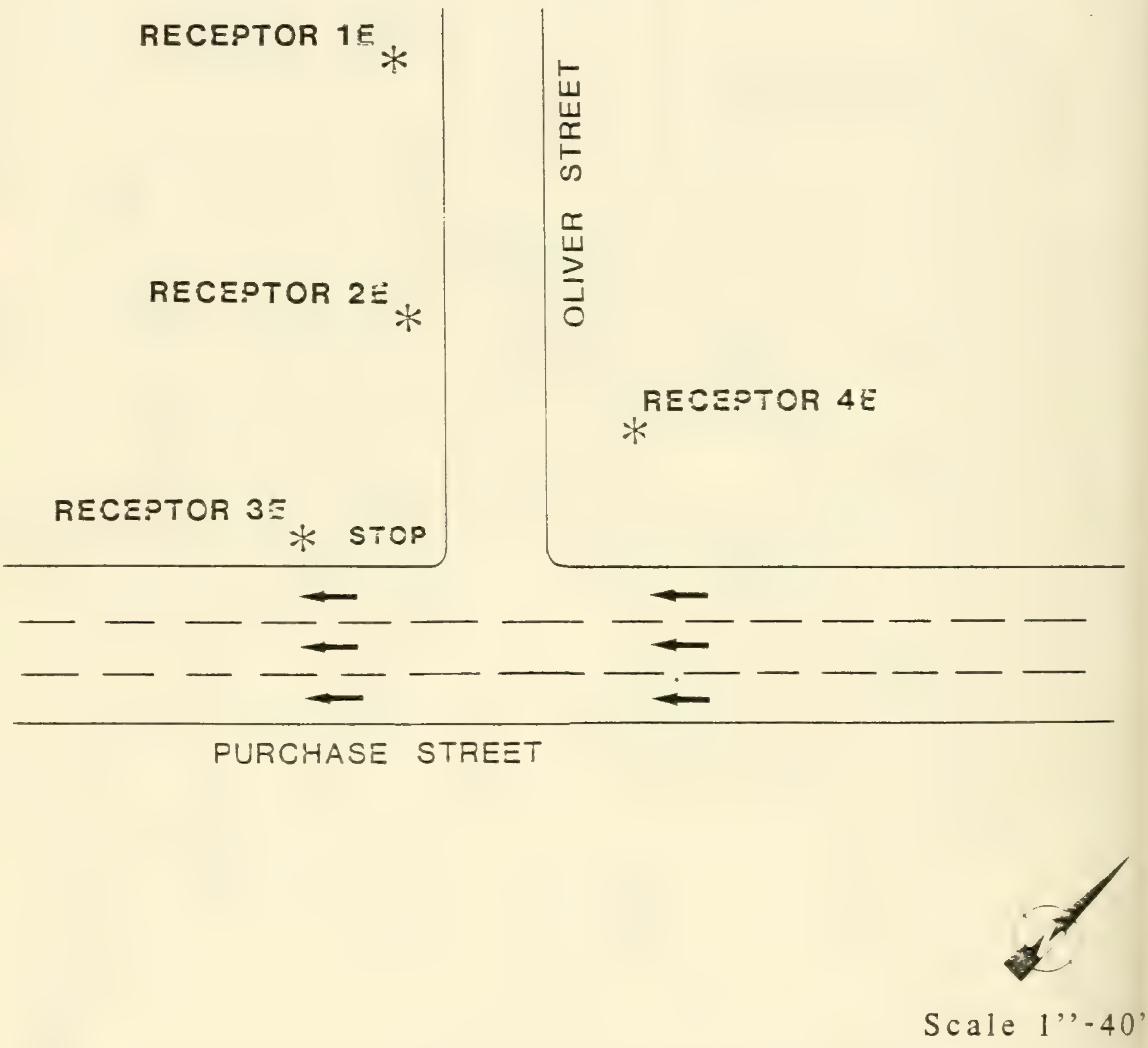

FIGURE 6.6-6 EXISTING PURCHASE STREET/OLIVER STREET

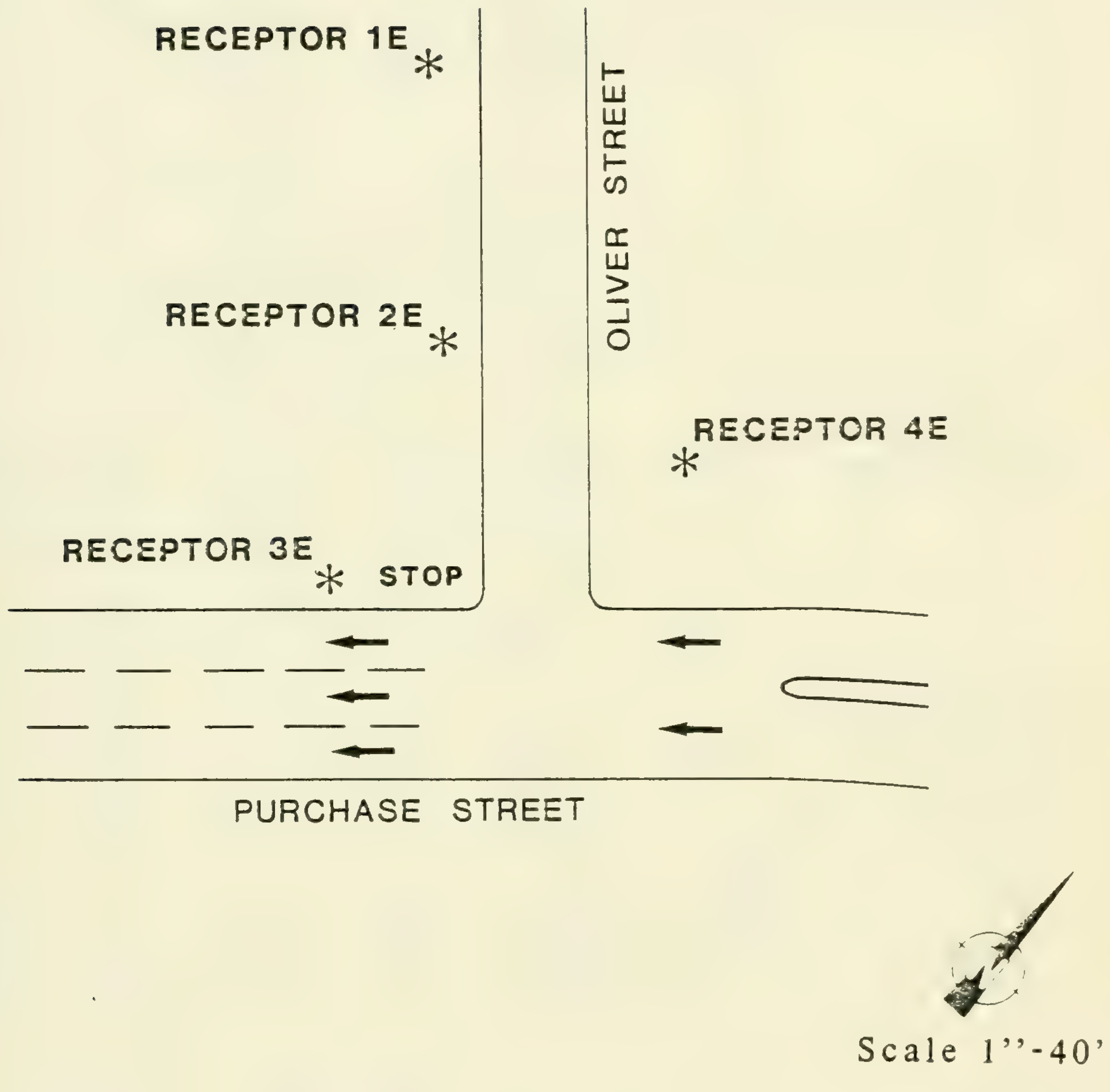

FIGURE 6.6-7 PROPOSED PURCHASE STREET/OLIVER STREET

TABLE 6.6-1

INTERSECTION ANALYSIS: MAXIMUM PREDICTED CO IMPACTS (PPM)*

Intersection	Receptor	Existing		1994 No-Build		1994 Build	
		1 Hr	8 Hr	1 Hr	8 Hr	1 Hr	8 H
Congress/	1A	28.1	11.5	19.0	8.4	21.1	8.
Purchase	2A	26.5	13.5	22.4	9.5	22.4	9
	3A	29.5	14.3	19.7	9.1	19.7	9.
	4A	23.0	10.7	19.5	7.8	19.3	7.
Atlantic/	1B	22.9	11.6	14.3	7.3	14.6	7
Congress	2B	24.8	11.9	15.6	7.3	16.2	7
	3B	25.8	12.7	16.0	7.8	16.2	7
	4B	23.6	12.3	17.5	8.0	18.0	8
Atlantic/	1C	17.9	8.9	13.6	6.4	13.8	6
Surface/High	2C	17.7	8.6	13.8	6.2	14.4	6
	3C	20.8	10.1	15.0	7.4	15.9	7
	4C	16.0	8.6	11.6	5.8	11.8	5
	5C	19.6	9.8	13.7	6.7	14.0	6
Atlantic/	1D	10.6	5.0	15.3	7.0	15.4	7
Northern	2D	13.5	5.7	11.5	5.5	11.5	5
Purchase/	1E	12.3	4.1	7.4	3.9	7.7	4
Oliver	2E	14.9	4.2	8.3	4.2	8.9	4
	3E	13.1	4.7	11.5	5.0	12.9	5
	4E	15.2	4.4	10.5	4.7	11.5	5

* Background levels included: 6.0 ppm (1-Hour) and 3.6 ppm (8-Hour

Parking Garage Analysis

CO impacts from One Twenty Five High Street's parking garage ventilation system were calculated using Halitsky's gas diffusion equation at all receptors examined for the intersection analysis. The system's exhaust vents are proposed to be located at the projects Pearl Street/Purchase Street corner at least ten feet above ground-level consistent with building code regulations and other locations. Table 6.6-2 summarizes the impacts of the parking garage.

Cumulative Results

The cumulative results of the intersection analysis, parking garage impacts and background levels at each receptor are presented in Table 6.6-3. These results do not characterize typical air pollution levels in the study area. Rather, they represent the highest concentrations that could exist during the joint occurrence of worst case meteorology and peak traffic. CO impacts at each intersection are as follows:

Purchase Street/Congress Street: The air quality analysis, at this intersection, did not predict a violation of the CO one-hour NAAQS of 35 ppm for any case studied. The highest one-hour concentration was 29.5 ppm which occurred under the existing configuration at receptor 3A along the south side of Congress Street west of Purchase Street. Likewise, the highest eight-hour level of 14.3 ppm was predicted under the existing configuration at this receptor. This concentration is 5.3 ppm above the eight-hour CO standard of 9.0 ppm. Since the modeling is based on conservative assumptions this only represents a potential existing violation.

TABLE 6.6-2

PARKING GARAGE ANALYSIS: MAXIMUM PREDICTED IMPACTS CO (PPM)

Intersection	Receptor	1994 Build	
		1-Hr	8-Hr
Congress/Purchase	1A	0.8	0.1
	2A	0.8	0.1
	3A	0.7	0.1
	4A	0.8	0.1
Atlantic/Congress	1B	0.6	0.1
	2B	0.7	0.1
	3B	0.7	0.1
	4B	0.6	0.1
Atlantic/Surface/High	1C	0.3	0.1
	2C	0.4	0.1
	3C	0.3	0.0
	4C	0.3	0.0
	5C	0.3	0.0
Atlantic/Northern	1D	0.4	0.1
	2D	0.4	0.1
Purchase/Oliver	1E	0.6	0.1
	2E	0.6	0.1
	3E	0.7	0.1
	4E	0.6	0.1

TABLE 6.6-3

CUMULATIVE MAXIMUM PREDICTED IMPACTS CO (PPM)*

Inter-section	Receptor	Existing 1 Hr	Existing 8 Hr	1994 No-Build 1 Hr	1994 No-Build 8 Hr	1994 Build 1 Hr	1994 Build 8 Hr	NAAQS 1 Hr	NAAQS 8 Hr
Congress/ Purchase	1A	28.1	11.5	19.0	8.4	21.9	8.4**	35	9
	2A	26.5	13.5	22.4	9.5	22.4**	9.5**	35	9
	3A	29.5	14.3	19.7	9.1	20.0	9.2	35	9
	4A	23.0	10.7	19.5	7.8	20.1	7.8**	35	9
Atlantic/ Congress	1B	22.9	11.6	14.3	7.3	15.2	7.4	35	9
	2B	24.8	11.9	15.6	7.3	16.9	7.5	35	9
	3B	25.8	12.7	16.0	7.8	16.9	7.9	35	9
	4B	23.6	12.3	17.5	8.0	18.6	8.3	35	9
Atlantic/ Surface/High	1C	17.9	8.9	13.6	6.4	14.1	6.5	35	9
	2C	17.7	8.6	13.8	6.2	14.8	6.7	35	9
	3C	20.8	10.1	15.0	7.4	16.2	7.4	35	9
	4C	16.0	8.6	11.6	5.8	12.1	5.9	35	9
	5C	19.6	9.8	13.7	6.7	14.3	6.8	35	9
Atlantic/ Northern	1D	10.6	5.0	15.3	7.0	15.8	7.2	35	9
	2D	13.5	5.7	11.5	5.5	11.9	5.7	35	9
Purchase/ Oliver	1E	12.3	4.1	7.4	3.9	8.3	4.2	35	9
	2E	14.9	4.2	8.3	4.2	9.5	4.4	35	9
	3E	13.1	4.7	11.5	5.0	13.6	5.4	35	9
	4E	15.2	4.4	10.5	4.7	12.1	5.1	35	9

* Background levels are included.

** No contribution from the proposed parking garage is included as highest concentrations predicted by the intersection analysis were a result of west through northwest winds. Under these wind conditions, emissions from the parking garage are blown in the opposite direction of the Purchase/Congress Street intersection.

During the future cases overall CO levels are lower than during existing cases, though, exceedences of the eight-hour standard are still predicted at receptors 2A and 3A. At receptor 2A, the modeling results demonstrate that violations of the eight-hour standard (of 9 ppm) occur when winds are from between 280 and 310 degrees clockwise from the north (i.e., from around the west-northwest). Under these wind conditions, the air quality modeling results further demonstrate that all intersection CO contributors are from the Congress Street roadway link west of Purchase Street (i.e., Congress Street eastbound). Reference to Figure 6.6-1 clarifies this point by showing that when winds are from the lower left-hand corner of the figure (i.e., west-northwest), only emissions from motor vehicles on the eastbound link of Congress Street will be directed toward receptor 2A. Traffic volumes, however, under the Build case, remain unchanged from those of the No-Build case, at this eastbound link of Congress Street (see Worksheet 1 in Appendix C), as the project's generated traffic will empty onto Purchase Street north of this intersection. In addition, any CO emissions from the project's parking garage (located to the top of Figure 6.6-17) will be blown away from this intersection under west-northwesterly winds. As such, the project does not cause or add to violations of the eight-hour CO NAAQS at receptor 2A. These predicted violations are a result of existing conditions.

At receptor 3A, the project shows its only violation of the NAAQS for CO by adding 0.1 ppm to an existing violation of 9.1 ppm. Modeling results indicate this violation occurs when winds are from only 80 degrees (east) clockwise from the north. For all other wind directions no violations of the NAAQS occur. For winds from between 50 to 90 degrees, CO levels of 8.5 to 8.9 ppm, approaching the standard, are predicted for both the future Build and No-Build cases. Similar to impacts at Receptor 2A the greatest CO contributions are a result of emissions from the queue of the eastbound link on Congress Street. As a result signal timing adjustments to provide additional green time to the Congress Street eastbound link should reduce CO levels at

receptor 3A (and also 2A) and potentially eliminates the predicted violations. Further discussion on signal timing adjustment and its effect are discussed in Section 6.6.6 (Mitigation Measures).

Atlantic Avenue/Congress Street: Under the existing case, no violations of the one-hour NAAQS were predicted at this intersection. However, the maximum predicted eight-hour results ranged from 11.6 ppm to 12.7 ppm. These represent exceedances of the 8-hour NAAQS of 9 ppm. The air quality analysis demonstrated that by 1994, for both the No-Build and Build cases, CO levels for the one- and eight-hour periods will be below the NAAQS. This is directly related to the emission reductions required of automobile manufacturers. Under the Build configuration, the highest one-hour and eight-hour CO concentrations were predicted to be 16.9 ppm (at receptors 2B and 2C) and 7.9 ppm (at receptor 2C), respectively. Only small pollutant level increases from the No-Build to Build cases are anticipated as demonstrated in Table 6.6.3.

Atlantic Avenue/Surface Artery/High Street: For the existing configuration, violations of the eight-hour NAAQS were only predicted at two of the five receptor locations modeled around this intersection. At receptor 3C located to the northeast of the intersection an eight-hour CO concentration of 10.1 ppm was predicted. This is 1.1 ppm above the eight-hour NAAQS of 9 ppm. At receptor 5C near Rowes Wharf, a maximum concentration of 9.8 ppm was predicted; this is 0.8 ppm above the allowable standard. By 1994, following reduction of motor vehicle emissions, the air quality analysis predicts all CO levels at this intersection to be below the NAAQS. For the one-hour period, the maximum CO level under the Build case and greatest increase from the No-Build configuration, occurs at receptor 3C. At this location the No-Build concentration of 15.0 ppm increases to 16.2 ppm under the Build case. For the eight-hour period the maximum Build concentration is 7.4 ppm at

receptor 3C; this is identical to the No-Build case. The maximum increase for the eight-hour period occurs at receptor 2C where an increase of 0.5 ppm is predicted.

Atlantic Avenue/Northern Avenue: The modeling analysis demonstrated no violation of the NAAQS at this intersection. It should be noted that at this intersection the peak AM period was examined as traffic data reflected insignificant volume increases at this location during the peak evening hour. The highest one-hour and eight-hour concentrations were predicted under the future Build case at the James Hook receptor (1D). At this location, one- and eight-hour concentrations of 15.8 ppm and 7.2 ppm were calculated. These values are both well below the CO NAAQS. CO level increases at this location, from the No-Build to Build cases, were 0.5 ppm for the one-hour averaging period and 0.2 ppm for the eight-hour averaging period.

Purchase Street/Oliver Street: The air quality analysis for this intersection predicted no exceedences of either the one- or eight-hour CO NAAQS under any case. The analysis indicated a highest 1-hour concentration of 15.2 ppm at receptor 4E under the existing configuration. A highest 8-hour CO level of 5.4 ppm was calculated at receptor 3E under the future Build configuration. Both of these represent maximum levels well below the NAAQS for CO. A maximum one-hour increase of 2.1 ppm from the No-Build to Build case was predicted at receptor 3E for the peak one-hour period. For the eight-hour period, a maximum increase of 0.4 ppm was estimated at receptors 3E and 4E.

6.6.6 Mitigation Measures

Inspection Maintenance Program

The Commonwealth's Inspection and Maintenance (I&M) program started on April 1, 1983 and has been assumed in the calculation of motor vehicle emission rates. This program, which results in the overall reduction of yearly motor vehicle emissions, was

established to ensure compliance with the NAAQS as outlined in the Massachusetts State Implementation Plan. The attainment and maintenance of the NAAQS for CO in the future is dependent on the continued enforcement of this program.

Traffic Demand Reduction Measures

Other traffic-related mitigation measures to reduce vehicle conflicts and delays could similarly improve existing and future air quality. Such traffic-related measures include van and car pooling which reduce traffic volumes.

A comprehensive Access Plan has been proposed for this project by the proponent. The purpose of the Access Plan is to elicit commitments from the proponent aimed at reducing the amount of traffic, and therefore, CO emissions, associated with the project.

The demand reduction mitigation measures to which the proponent has committed include:

- Ride Sharing - encouraging use of carpools and vanpools by providing an on-site ride matching program, provision of promotional materials, and coordination with Caravan or other similar vanpool providers.

- Public Transportation - encouraging use of mass transit by selling bus and MBTA passes on-site, promoting tenant subsidies, provision of bus and train schedules and other promotional material.

- Alternative Work Schedules - reducing peak-hour demands by promoting flex-time (currently in place at NET), providing off-hours building services.

- Parking Supply Management - parking spaces will be managed to reduce peak-hour trips, including preferred high occupancy vehicle (HOV) spaces and reserving spaces for off-peak arrivals.

- Delivery Vehicles - all deliveries and loading are accommodated off the street, with loading available 24-hours per day to encourage off-peak deliveries.

- Bicycle storage available.

- A transportation coordinator will be appointed on the building staff to monitor implementation of the plan.

Capacity Enhancement of Roadways

The City of Boston Transportation Department is currently involved in a major signal upgrading program for the downtown area. This program envisions computerized, phased signal timing in the downtown area, including the project study area. This program is described in more detail in the following section.

Signal timing changes which enhance traffic movement, roadway geometry changes which increase roadway capacities, and removal of on-street parking which also increases roadway capacities produce positive effects in reducing vehicle emissions of pollutants. In addition, planned roadway improvements, such as the Dewey Square Transportation Systems Management (TSM) program, which the project proponent is committed to support, will provide general traffic flow improvements in the downtown area and thus produce air quality benefits.

At the intersection of Purchase and Congress Streets, where the only violations of the NAAQS for CO occurred, both the proponent's commitment to ride sharing and the City's elimination of curb side parking along Purchase Street* should

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* One Twenty Five High Street Draft EIA, Section 6.1.4.3, Filed with the Boston Redevelopment Authority, December, 1986.

provide improvements of predicted project generated air quality impacts. Discussions regarding use of Purchase Street are ongoing with the I-90/I-93 project team to ensure coordination at this location. The project's Access Plan* demonstrates a reduction of V/C levels as a result of the removal of the curb side parking along Purchase Street southbound. Improved traffic flow at this location should reduce delays and likewise reduce CO levels. The air quality modeling results, however as described above, demonstrate CO emissions from motor vehicles at the eastbound queue of Congress Street to be the primary contributor to exceedances of the 9 ppm eight-hour CO standard. Since CO levels are proportional to roadway queues and percent red time, signal timing adjustment for providing additional green time to this link was investigated. Presently the intersection operates under the following signal permit timings:

i) Phase A - Purchase Street SB Left: 16 seconds

ii) Phase B - Purchase Street SB Straight and Left: 36 seconds

iii) Phase C - Congress Street EB: 38 seconds

By providing Congress Street (Phase C) an additional eight seconds of green time at the expense of the advance Purchase Street left movement (Phase A), modeling results demonstrate the following maximum predicted eight-hour Build CO levels at receptors 1A through 4A:**

- Receptor 1A - 8.4 ppm (0.0 ppm)
- Receptor 2A - 8.4 ppm (-1.1 ppm)
- Receptor 3A - 8.8 ppm (-0.4 ppm)
- Receptor 4A - 8.3 ppm (+0.5 ppm)

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* One Twenty Five High Street Draft EIA, Section 6.1.4.3, Filed with the Boston Redevelopment Authority, December, 1986.

** The values in parenthesis show change from the non-mitigation case (see Table 6.6-3)

These results demonstrate a general improvement and that a timing adjustment eliminates predicted future violations.

City of Boston Plans

Currently the City of Boston is in the process of optimizing, through computer operated traffic flow monitors, approximately 250 signals in downtown including the project study area. Completion of this program is expected prior to 1994. Computer driven signal timings based on demand should improve traffic flow over peak one- and eight-hour periods in the project area. During eight-hour periods, when the only violations of the NAAQS for CO were predicted (prior to mitigation) with this project, continual monitoring of traffic conditions and appropriate adjustment to signal timings under this program should provide significant potential air quality benefits. These benefits should be realized not only at the Purchase and Congress Street intersection but also the other signalized intersections studied which will be included in this program. Also, the overall effect of this program should be to reduce CO background levels as general flow in the downtown area will improve.

Effect of I-90/I-93 Plans

Further roadway improvements in Boston, associated with the Third Harbor Tunnel and depressed Central Artery (as currently being considered) are also expected to improve air quality in the project area. The depressed artery will include the diversion of northbound traffic on the artery around the project area (to the east) instead of through downtown Boston.* As a result, northbound on and off-ramps of the artery to Atlantic Avenue will no longer exist. The diversion of the Artery

* Presently funding for this project is not finalized, however, the potential of the project is favorable.

northbound traffic through the Fort Point Channel area will result in improved V/C ratios at the intersections of Atlantic Atlantic Avenue/Congress Street and Atlantic Avenue/Northern Avenue. Most significant benefits will be noted at the existing Surface Artery/High Street/Atlantic Avenue intersection. At this location a radical redesign will simplify traffic flow through this intersection.

The Fan Pier/Pier 4 Draft EIR notes that when the predicted CO levels for 1995 Build with Third Harbor Crossing and 1995 Build without Third Harbor Crossing are compared, "the Third Harbor Crossing is seen to be a significant, and far-reaching, mitigating measure for air quality impacts. The Third Harbor Crossing will reduce maximum 8-hour and CO concentrations by 0.5 ppm or more at the following 12 intersections:

- West Broadway and D Street (-0.8 ppm)
- Old Colony Avenue and D Street (-0.5 ppm)
- West Broadway and A Street (-0.7 ppm)
- West Fourth Street and Frontage Road (-2.0 ppm)
- Summer Street and Viaduct Street (-1.5 ppm)
- Summer Street and Atlantic Avenue (-1.3 ppm)
- Northern Avenue and Atlantic Avenue (-0.9 ppm)
- Summer Street and D Street (-0.8 ppm)
- High Street and Atlantic Avenue (-3.5 ppm)
- New Northern Avenue and Sleeper Street (-0.7 ppm)
- New Northern Avenue and Pittsburgh Street (-1.0 ppm)
- New Northern Avenue and Seaport Access Road Entrance (-1.1 ppm)"*

The analysis above considered the Third Harbor Tunnel but not the proposed Central Artery Depression. Due to the improvements in traffic operations resulting from the Central Artery Depression, it can be expected that further air quality benefits may be realized.

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* Fan Pier/Pier 4 Development Draft Environmental Impact Report, EOEA # 4426/4584, December 1985. Page IV.2-8.

Emissions Limitations

Another mitigating factor utilized in the air quality analysis is the effect of the federal emissions limits required of automobile manufacturers. The MOBILE3 computer program used to develop emissions for both the intersection and parking garage analyses incorporate these emissions limitations. These emission limits were not, however, factored into background CO levels. For the project area, motor vehicle emissions (provided in Appendix C) are reduced by 44 percent from 1986 to 1994. Correspondingly, traffic volumes contributing to background are expected to grow approximately 27 percent during this period. Factoring these elements into the existing one- and eight-hour background levels of 6.0 ppm and 3.6 ppm, translates to 1994 levels of 4.3 ppm and 2.6 ppm, respectively. Utilizing credits of the federal emissions limits "across the board" (carried through background levels as well as CO contribution from the intersection and garage analyses) will result in future one-hour and eight-hour levels being reduced by 1.7 ppm and 1.0 ppm, respectively, in Table 6.6-3. This consideration alone would eliminate any potential future violations of the eight-hour standard at the Purchase Street/Congress Street intersection.

6.6.7 Proposed Building Effects on Pollutant Dispersion

One Twenty Five High Street under the proposed configuration will modify the local wind climate and therefore alter the transport and diffusion of air pollutants. Wind tunnel and field experiments demonstrate the potential for a stagnation point about two-thirds of the way up a high-rise building on the upwind facade.* Below this point, winds are deflected to the ground as upper level winds against the upper face of a

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* Hanna, Steven R., Gary A. Briggs, Rayford P. Hosker, Jr., Handbook on Atmospheric Diffusion, Technical Information Center, U.S. Dept. of Energy, 1982, p. 19.

high-rise building create a downward pressure gradient. Also, turbulence is generated on the side and roof, and downwind of a cavity of recirculating air on the lee side of the building. The lee side turbulence becomes more evident as the obstacle becomes less rounded, taller or warmer relative to the ambient air. In general, these effects will enhance diffusion of pollutants as upper level winds are deflected to the ground and pass around the building elements. Induced turbulence will also increase the rate of dispersion on the lee side of a high-rise building. Immediately adjacent to the lee side of the building, in the cavity of recirculating air, pollutants are well mixed with upper levels such that pollutant concentrations are generally more uniform in this region.

For this project, results of the pedestrian level wind study (see Chapter 6.2) confirm these general wind tunnel observations and demonstrate that some wind speed increases at building corners are expected while lower wind speeds are anticipated at locations sheltered by the proposed complex. At the upwind faces and corners of the project, increased wind speeds should provide additional diffusion of pollutants thus lowering concentrations (concentrations are inversely proportional to wind speed). At locations downwind of the project where wind speeds may decrease, the enhanced level of turbulence in the wake region and mixing (with upper level winds) in the cavity region will increase dispersion of pollutants. Beyond the downwind wake region away from the project, decreases in wind speed which may inhibit pollutant diffusion, are expected to be small, if not insignificant. As a result, the overall mixing action of the project is expected to largely outweigh any small wind speed decreases away from the project site.

6.6.8 Construction Related Impacts

Project related air quality impacts are anticipated to be limited to emissions of fugitive dust during the 6 year construction period. Impacts associated with demolition blasting, land clearing, ground excavation, cut-and-fill operations and other construction activities may generate fugitive dust, which will result in localized increases in total suspended particulate (TSP) levels. Fugitive dust emissions from construction activities will depend on such factors as the properties of the emitting surfaces (e.g. soil silt content, moisture content, and volume of spoils), meteorological variables, and construction practices employed. It is anticipated that emissions from aggregate storage piles will be minimal as the project site is small, thus limiting its storage capacity.

The EPA document AP-42* provides an emission factor of 1.2 tons of TSP emitted per acre of construction per month for heavy construction operations. This emission value is based on field measurements and applies to a typical area having a precipitation/evaporation (PE) index of 50. The PE index is a measure of the precipitation to evaporation ratio and in the contiguous United States ranges from an approximate low of 10 in the arid southwest to approximately 170 in the upper northeast. In the Boston area, the PE index is 132, well above the level of 50 which applies to the 1.2 tons factor. Indications are that TSP emissions from heavy construction activities are inversely proportional to the square of the PE index, thus for Boston a value of 0.17 tons per acre of construction per month was developed based on a PE index of 132 instead of 50.

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* EPA, "Compilation of Air Pollution Emission Factors," AP-42, Fourth Edition, RTP, NC, September 1985.

Applying this factor to the construction area results in the following estimates of potential fugitive dust emissions over the construction period:

Construction Period* (months)	Area (Acres)	TSP Emissions (Tons)
36	2.5	15.3

To reduce emissions of fugitive dust and minimize impacts on the local environment, a number of strictly enforced mitigation measures will be adhered to. These include:

- The use of wetting agents on areas of exposed soil on a scheduled basis.
- Use of covered trucks.
- Storage of very few spoils on the construction site.
- Locating aggregate storage piles away from areas having the greatest pedestrian activity.
- Monitoring of actual construction practices to ensure that unnecessary transfers and mechanical disturbances of loose materials are minimized.

Finally, during the demolition phase which covers approximately 6 months of the six year construction period, all Federal, state and city demolition-related requirements will be met prior to commencement. In addition, while demolition activities are ongoing, the project proponent will insure that all necessary precautionary measures will be taken to protect the public.

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* Dust generating activities assumed to take place during 50% of total construction period of 6 years. Construction period includes the approximate 6 month demolition phase.

6.7 NOISE IMPACTS

No adverse noise impacts are expected to result from either the construction or operation of One Twenty Five High Street. Existing ambient noise levels in the areas surrounding the project site are fairly high, primarily as a result of their proximity to the Central Artery and busy urban streets. Land use in the area is mainly commercial/office space; no residential properties or other noise-sensitive land uses are located near the site. (The nearest residential properties are Harbor Towers and Rowes Wharf, located across the Central Artery, some 900 feet northeast of the site.)

6.7.1 Noise Level Measurements

A brief noise level survey was conducted near the proposed project on the afternoon of September 17, 1986. Because of the vast amount of construction work and street excavation in the area, it was virtually impossible to find a position near the site where noise levels were not influenced by construction equipment noise. The least influenced location, interestingly enough, was found to be on the corner of Oliver and High Streets, across from the International Place construction site; only finish work and siding placement were occuring there, and any noise generated was mainly contained inside the building.

Background L_{90} noise levels at this location were found to be in the mid-60's dBA, completely dominated by traffic noise from both the Central Artery and the local side streets. Average L_{50} levels were found to be just slightly higher (upper 60s dBA), indicating that the ambient noise levels are fairly constant. So-called "near-peak" L_{10} levels were in the mid-70s dBA, again influenced primarily by passing vehicles. Noise from the International Place construction activities at mid-day was virtually indistinguishable from the background noise.

Given the homogeneous nature of the site environs, it is expected that the background noise levels measured at the corner of Oliver and High Streets would be fairly representative of the background levels (in the absence of construction noise) throughout the area surrounding One Twenty Five High Street.

Noise level measurements were also made at several other construction sites in the downtown Boston area, within several blocks of One Twenty Five High Street. The purpose of these measurements was to gather representative noise level data on the various types of construction activities that will occur during the construction phase of the proposed project. In addition to the acoustical measurements taken of the siding and finish work at International Place, noise level readings were made of concrete placement (across from 100 Federal Street) and steel erection (across High Street from the Keystone Building).

Noise from the climbing-tower crane in use at the 75/101 Federal Street construction site dominated the site's overall noise emissions. Noise measurements taken at street-level from across Federal Street (next to the main entrance to 100 Federal Street) showed noise levels in the upper-70s to low-80s dBA when the crane was in operation. Crane noise was found to be almost continuous, and was evident for about 85 percent of the 10-minute noise measurement period. An L_{10} level (the level exceeded 10 percent of the time) of 82 dBA was observed. Because of the almost continuous nature of the crane noise, the average (L_{50}) noise level (about 79 dBA) was only slightly less than the L_{10} level. When the crane was not operating, the background (L_{90}) level was found to be about 74 dBA, dominated by street traffic noise.

Riveting and hammering dominated the noise coming from the steel erection activities at the construction site across High Street from the Keystone Building. Street-level noise measurements made near the main entrance to the Keystone Building showed L_{10} levels of about 86 dBA, controlled primarily by noise from riveting and hammering. These activities were intermittent in nature, occurring for just about 10 percent of the 10-minute noise measurement period. Air compressors were also found to strongly influence the overall noise emissions from the site. When noise from riveting and hammering was not present, noise levels fell to the mid- to upper-70s dBA. An average (L_{50}) level of 77 dBA was measured, influenced primarily by compressor noise; a background (L_{90}) level of 74 dBA, controlled by both compressor noise and noise from street traffic, was observed.

The construction site noise measurements are summarized in Table 6.7-1.

Construction Noise Impacts

Because of the generally high existing traffic noise levels in the area around One Twenty Five High Street, overall construction noise impacts will be minimal. Much of the noise associated with the project will be a result of the large number of trucks that will be used both to haul away demolition debris from the existing Travelers Building and to bring building materials and construction equipment to the site. However, the noise from these trucks will tend to "blend in" with the existing traffic noise in the area, and should not be perceived as a significant increase in the overall levels of traffic noise.

TABLE 6.7-1

NOISE LEVELS OF TYPICAL DOWNTOWN BOSTON CONSTRUCTION ACTIVITIES

Activity	Measurement Location	L10	L50	L90	Major Noise Sources
Concrete Placement	Street level, in front of the 100 Federal Street Building, directly across the street from the 75/101 Federal Street Project	82	79	74	Crane motor, some sawing Background: traffic
Steel Erection	Street level in front of the Keystone Building; directly across High Street from construction activities	86	77	74	Hammering, riveting, trucks Background: air compressors, traffic
Siding and Finish Work	Street level, corner of High Street and Oliver Street, across Oliver Street from International Place construction	76	67	64	Traffic Background: traffic (Note: construction activities rarely audible.)

NOTES: All measurements made between 2:30 and 3:30 PM, September 17, 1986, using GenRad Type 1933 Precision Sound Level Meter (ANSI S1.4-1984 Type "1"). Meter field-calibrated before and after measurements. All measurements reported in dBA, re: 20 micropascals.

Two options are available for the demolition of the existing Travelers Building: implosion techniques or ball-and-crane wrecking. If implosion techniques are used, demolition noise impacts will be limited to the several-second duration of the actual blasts. Because of the safety hazards imposed by implosion, the area will be cleared prior to the blasts, and no people will be exposed to excessive noise levels.

Use of ball-and-crane wrecking techniques will extend demolition noise over a period of several months, during which time a fairly steady series of impact noises (crashes and bangs) will be produced, both by the wrecking ball itself and by falling debris. Although the noises produced during ball-and-crane demolition will not be loud enough to result in any offsite hearing damage, they are likely to cause "startle" reactions in the area, exacerbated by the irregular intervals with which the noises occur.

Removal of demolition debris will take place for several weeks after implosion, or concurrently during ball-and-crane wrecking. During this time, and during the subsequent excavation phases, a large number of trucks will be used to haul debris and excavated material from the site. The number of trucks and, therefore, the amount of truck noise in the area will increase during these periods. However, only a slight incremental increase in the overall traffic noise levels in the area is expected to result from project-related truck traffic.

Also associated with the excavation of the site will be a large amount of diesel-powered earthmoving equipment. Again, however, because the existing ambient noise levels in the area are already highly influenced by motor noise, only slight incremental noise level increases are expected during the excavation activities. Furthermore, the walls of the excavation will serve as noise barriers, reducing street-level excavation noise as excavation continues down some six levels.

Some sheet-piling may be used for temporary retaining walls during excavation, and will likely create high levels of impact noise. However, the use of pile drivers will be limited in duration and should not result in more than temporary annoyance to those near the project site. No continuous pile driving is planned for the building structure.

Foundation work for the project will consist mainly of pre-drilled concrete pilings cast in place. Concrete will be brought to the site in cement trucks, again with only slight incremental increases in overall traffic noise levels. A large, diesel-powered climbing-tower crane will likely be used in the form, reinforcement, and concrete placement, which is likely to result in increased ambient noise levels in the surrounding area. Noise levels similar to those measured across the street from the 75/101 Federal Street construction site (see discussion of construction noise measurements, above, and Table 6.7-1) are likely to occur during foundation work for One Twenty Five High Street; fairly continuous noise levels in the upper-70s to low-80s dBA on the sidewalks around the site are expected to occur when the climbing-tower crane is in operation.

The steel erection phase of construction is also expected to generate noise level increases in the surrounding area. The climbing-tower crane will also be used during steel erection, and will likely cause continuous noise levels in the upper-70s to low-80s dBA throughout the steel erection phase. Intermittent noise levels in the mid-80s dBA are expected from riveting and hammering during steel erection, as were measured from construction across the street from the Keystone Building (see discussion of construction noise measurements, above, and Table 6.7-1).

During the siding installation and finish work phases of construction, noise levels from One Twenty Five High Street are expected to be minimal, based on observations made at International Place, just north of the site (see discussion on existing ambient noise levels, above, and Table 6.7-1).

Despite the high levels of noise expected from several of the construction phases of the project, no adverse noise impacts are expected to occur. There are no noise-sensitive receptors or land uses near the project site. People potentially impacted by construction noise emissions from the project are mostly employees working inside air-conditioned offices near the site, who will receive the benefit of the typically high noise reductions associated with closed-window office buildings. Pedestrians near the site will receive the highest construction noise levels, but only for the brief period of time they require to walk past the site.

As mentioned previously, existing ambient noise levels in the area are already quite high, as would normally be expected in such a dense urban business area. In addition, there is an inordinately high number of major new construction and redevelopment projects going on within the relatively small downtown Boston area, and people have grown accustomed to construction noise throughout the area. Because the high buildings in downtown Boston serve as effective noise barriers, the noise from any one construction project is typically confined to a fairly limited (several-block) area, but the density of projects has had the effect that it is almost impossible to go anywhere downtown without hearing construction noise. In this sense, construction of One Twenty Five High Street will result in fewer noise impacts than many other projects; it is located at the very edge of the business district, abutting the Central Artery, and has far less pedestrian traffic, and fewer near-by office workers, to impact with construction noise than do projects more centrally located.

6.7.2 Operational Noise Impacts

Once the construction is complete, there will be no noise impacts from One Twenty Five High Street. As is typical for such large office buildings, some noise is expected to be produced by the building mechanical systems (heating, ventilation, and air-conditioning). However, the noise from the Central Artery and busy urban street traffic is expected to completely mask any HVAC noise generated, particularly at street-level.

Noise from the Fire Station

One unique aspect of One Twenty Five High Street will include a new Boston fire station that will replace the existing fire station on the site. Operating out of this fire station are several fire trucks and a rescue squad. This section discusses the impacts the fire trucks, particularly their sirens, will have on occupants of the proposed new buildings.

The noise from the sirens on the fire trucks is far louder than the general ambient noise levels in the area. Measurements made at the fire house entrance showed that noise levels reached about 98 dBA when the trucks left the station to respond to a fire. However, the duration of the noise was very brief. Less than 30 seconds elapsed from the time that the fire call came in to the time that the engines had left the station and were out of earshot.

Informal inquiries of this fire station's personnel indicated that, on average, the trucks respond to about a dozen calls each day. At night, calls are far more irregular than during the day, and the fire fighters were less specific about "average" numbers of nighttime calls -- some nights no calls

come in, and on others, they are kept very busy. However, they did indicate that 5 or 6 calls in a single night is considered "very busy". Thus, the assumption can be made that the trucks would be called out less than half a dozen times on an average night.

The firefighters also indicated that they do not use the sirens at night until they reach the main streets, although, because of traffic, they regularly use them from when they first leave the station during the day.

The sirens used contain most of their acoustical energy between about 500 and 2000 Hz*. Given noise levels of upwards of 100 dBA at street level when the engines pass by with their sirens on, the siren noise will certainly be audible inside nearby buildings. Typical sealed-window construction used in

* Humans can generally hear sounds with frequencies (measured in "Hertz" (Hz), or cycles-per-second) ranging from about 20 Hz to 20,000 Hz. However, humans do not hear equally well at all frequencies -- hearing sensitivity is greatest between about 500 Hz and 4,000 Hz; sensitivity to low-frequency sounds (below about 250 Hz) and high-frequency sounds (higher than 8,000 Hz) is greatly reduced. Thus, given two sounds with equal acoustical energy, one low-frequency, for example, with a frequency of 125 Hz, and a frequency of, say, 1,000 Hz, the low-frequency sound will "sound" quieter. The "A-weighted sound pressure level", specified in terms of "dBA", is a measure of the total amount of acoustical energy, at all frequencies, that is present at a given point; the "weighting", however, is introduced to more accurately reflect human response to different frequencies of sounds -- a noise containing most of its acoustical in the lower frequencies will have a lower "dBA level" than one with the same total amount of acoustical energy concentrated in the mid-frequencies.

  Because it is critical that people hear the warning sounds coming from such devices as fire-truck sirens, these devices have been designed to produce sounds in the frequency range to which most people are most sensitive.

modern high-rise buildings will reduce these levels by at least 40 decibels, resulting in indoor noise levels of less than about 60 dBA for street-level interior spaces; interior levels at higher elevations will likely be less because they are farther away from the souno source. Interior siren noise levels of this magnitude and the brief duration of the fire truck or ambulance passing may result in very minor interference with verbal communication. However, people generally recognize the importance of such emergency equipment, and are typically not adversely impacted or bothered by the noise that is made.

6.8 UTILITY SYSTEMS IMPACTS

6.8.1 Sewer System Introduction

The City of Boston has a public sewer system that is operated by the Boston Water and Sewer Commission (BWSC). Throughout most of the downtown and Financial Districts of the City, service consists of combined sewers. Sanitary wastewater and storm water from the existing buildings and surrounding area in the vicinity of High Street are collected by combined sewers and directed to the East Side Interceptor (ESI). The ESI passes close to the site and conveys the wastewater to the Boston Main Interceptor (BMI), and then on to the Massachusetts Water Resources Authority (MWRA) Deer Island Treatment Plant. At Deer Island the wastewater currently receives primary treatment and chlorination before being discharged to Boston Harbor.

6.8.2 Sewer System - Site Area

As shown in Figure 6.8-1, the site is serviced by sewers in Pearl Street, Purchase Street, and Oliver Street. A 24" x 27" combined sewer runs south along Pearl Street. It enters a 20" sewer which crosses under the Central Artery, enters a short stretch of 24" x 36" line, and then discharges into the ESI.

A 12" x 18" combined sewer runs southeast along Oliver Street. A 12" x 16" line runs to the northeast along Purchase Street; this line joins the 12" x 18" Oliver Street line at the corner of Oliver and Purchase Streets. The Oliver Street line discharges to a 16" x 24" line and a 72" diameter sewer which cross beneath the Central Artery, and discharge to the ESI.

A 12" x 16" line, which bisects the site, runs to the southeast between the existing Travelers Building and the Fort Hill Fire Station. It enters the 12" x 16" line on Purchase Street on the southeast edge of the site.

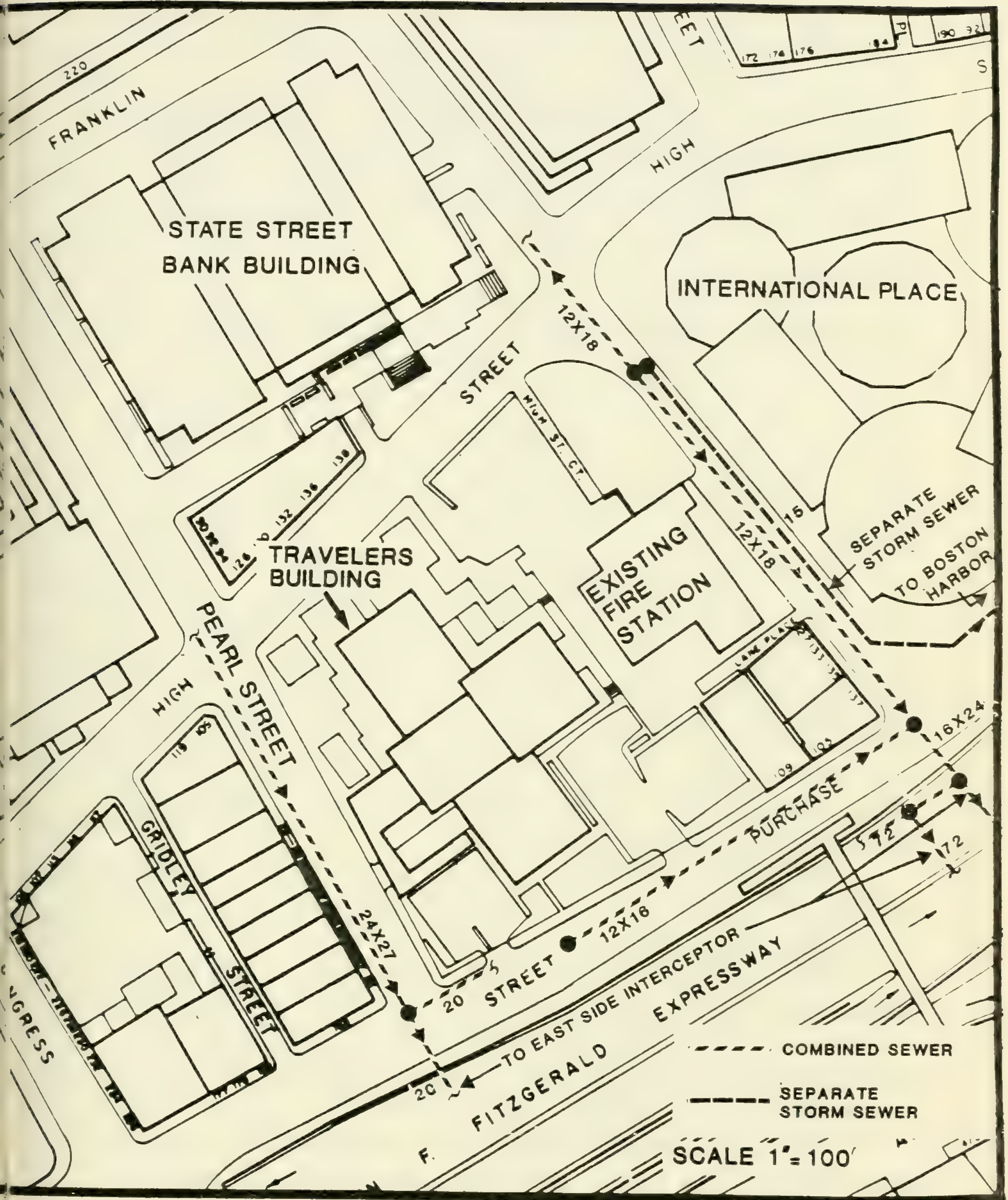

FIGURE 6.8-1 SITE AREA - EXISTING SEWERS

High Street, which forms the northwest edge of the site, marks a dividing point in the sewer system serving the general site area. The area on the project side of High Street drains to the ESI as described above. The sewers servicing the area northwest of High Street flow to the northwest. As a result, a very limited and well defined area is serviced by the portions of the Pearl, Purchase, and Oliver Streets sewers which service the project area.

Sanitary sewerage from One Twenty Five High Street will be contained in a holding tank which will be periodically pumped to the 12" x 18" combined sewer in Oliver Street. This 12" x 18" sewer in Oliver Street has sufficient capacity to receive sanitary flows from the project and other users of this line. The 12" x 16" line, currently bisecting the site, serves only the site itself. This line will be removed as part of this project.

A separate 15" storm drain has been installed along Oliver Street by the developers of International Place. The flow in this storm drain will be routed to a separate storm drain system at Rowe's Wharf. The design of the site drainage for One Twenty Five High Street will utilize as much excess capacity as is available in this separate storm drain system so as to divert the maximum amount of storm flow from the project site away from the combined sewers, and from the ESI. This represents an improvement over existing conditions.

The project will also provide separate storm sewers for the entire site so that future tie-in of remaining areas to separate storm drain systems can be facilitated.

The proponent may investigate other means of attenuating storm water discharge peaks, including the use of regulators in the building roof drainage system. This would allow for retention of approximately 3" of water build-up on the roof with slow drainage through weep holes.

Another mitigating measure being planned would eliminate the potential for coincident timing of discharge from the sanitary sewage holding tank and a peak storm event (such as a 3-hour heavy rainfall). This measure, an override mechanism

on the tidal clock controlling the tank discharge, would be an improvement over the existing situation where sanitary flows during the daytime may coincide with peak storm drainage.

Drainage from the underground parking garage will flow into a gas/oil separator and then discharge to the sanitary holding tank. The separator will be maintained to ensure adequate removal of gas/oil. Since this is an enclosed parking garage, drainage flow quantities will be somewhat limited.

6.8.3 Existing Sewer System and Planned Improvements - East Side Interceptor to Deer Island

East Side Interceptor

The ESI conveys dry weather flows and some wet weather flows from the downtown Financial District, the Waterfront area, the North End and portions of the South End, to the new BMI at the south end of the South Station Railroad Yard.

The ESI begins at Hanover Street in the North End and continues to the south along Commercial Street and then along Atlantic Avenue south to Beach Street. It then proceeds south, under the South Station Railroad Yard, and connects with the new BMI at the south end of the South Station Railroad Yard.

The portion of the ESI north of the site from Eastern Avenue to Harbor Towers was replaced as part of the Waterfront Park Project. The BWSC has initiated action to replace the remainder of the ESI. The replacement of the ESI between Rowes Wharf to the South Station Railroad Yard is being undertaken in phases, from south to north. A section from the south end of the South Station Railroad Yard to Kneeland Street was recently completed. In several months, after another section of the new ESI is completed under the South Station area itself, flows from the existing ESI in the area of Summer Street and Atlantic Avenue will be transferred to the completed portions of the new ESI.

Replacement of the ESI north of South Station to Rowes Wharf (which serves the area of the project site) is a two phase effort that should be fully completed in about 2-3 years. The section north of Northern Avenue is anticipated to begin construction shortly, while the portion south of Northern Avenue should begin construction next spring. Completion of these segments will complete the replacement of the entire BWSC interceptor system from the harborfront area to the connection with the MWRA system.

Boston Main Interceptor

In the new BMI, sewage generally flows from north to south through the southern part of downtown Boston. The BMI serves to convey flows from the other Boston interceptors (including the ESI) to the junction with the MWRA system in the Columbus Park area. The new BMI represents a complete replacement of the old BMI, which previously served the same major interceptors. Sewage in the new BMI flows southerly from the south end of the South Station Railroad Yard to Andrew Square in a 9,000 foot section of pipe that was completed in September 1986. Flow from Andrew Square to the MWRA Columbus Park Headworks is in a 2,650 foot section of pipe that was completed in May, 1984.

MWRA Tunnel to Deer Island

Wastewater collected in the BWSC's system enters the MWRA system at the Columbus Park Headworks which has a capacity of 180 million gallons per day (mgd). Average dry weather flow to the headworks is approximately 64 mgd. The MWRA Tunnel which conveys sewage from the Columbus Park Headworks to the Deer Island Treatment Plant has a peak capacity of 440 mgd.

Benefits of System Improvements - East Side and Boston Main Interceptor Replacement

Most water quality problems in the Inner Harbor can be significantly reduced if dry weather overflows are eliminated and if wet weather combined sewer overflows are minimized. Currently, the MWRA and the BWSC are working on elements of a recommended plan for control of combined sewer overflows (CSO). The plan is intended to eliminate dry weather overflow by in-system modifications to tidegates and regulators, by improvements in collection capacity, and by continuing inspection and maintenance programs.

The replacement of the BMI and ESI are significant portions of the BWSC's plan to improve water quality in the Inner Harbor. This sewer improvement program is a $60 million design and construction program to replace major sewer interceptor pipes. The program is designed to eliminate dry weather overflows, to minimize wet weather overflows caused by insufficient capacity in the existing systems, and to provide replacements where the system has deteriorated.

Plans for System Improvements at Deer Island Treatment Plant

The MWRA is currently in the process of upgrading the Deer Island Treatment Plant in two stages. The first stage is an immediate upgrade to improve pumping capacities at the plant. This program is intended to prevent situations where failure of pumping equipment at Deer Island leads to increased discharges at CSO facilities and the Moon Island outfall. This stage is intended to be complete by 1988.

The second stage is a complete construction of a new facility to upgrade treatment capability. A design contract for the treatment plant upgrade was recently awarded by MWRA. Parallel efforts are underway to site and design the required sludge management facilities. This program will extend into the mid 1990's.

6.8.4 Project Sewage and Storm Water Flows

One Twenty Five High Street is a commercial office building of approximately 1,275,442 net SF for office, 18,713 net SF retail, 18,424 net SF restaurants. It will replace existing space on the site totalling 377,000 net SF. The complete project will be constructed in one continuous effort, thus analysis of potential phased build-out is not considered necessary or appropriate to assess impacts.

Estimated Sewage Flow

1. Office Area: 1,275,442 net SF x 75 gallons per day (gpd) per 1,000 net SF* = 95,658 gpd

2. Retail: 18,713 net SF x 5 gpd per 100 net SF* = 935 gpd

3. Restaurants: 18,424-7,370 (Kitchen & Toilets) = 11,054 net SF seating area
11,054/15 net SF per seat = 736 seats x 35 gpd per seat* = 25,760 gpd

Total Sewage Load:

a.	Office	-	95,658 gpd
b.	Restaurants	-	935 gpd
c.	Retail	-	25,760 gpd
			122,353 gpd
d.	Less existing flows	-	-28,275 gpd
			94,100 gpd

* Per MA DEQE, Title 5, Sanitary Sewage Generation Factors (310 CMR 15.02)

For this type of occupancy, the sewage flows for the buildings will occur between 8:00 A.M. and 5:00 P.M. coinciding with the period when the City sewers will most likely be subject to surcharged conditions during periods of high tide. To overcome this possibility, a sewage holding tank will be engineered for this project. Sewage will be held and discharged during low-tide periods.

However, in determining the increment of flow attributable to the new development, it should be noted that the site is currently occupied by the 16-story Travelers Building and a 2-story City of Boston fire station for which current sewage generation is estimated to be 28,275 gpd. This estimate is based on approximately 377,000 net SF of space. The net additional sewage generation attributable to the proposed project is approximately 94,100 gpd.

Sewage Holding Tank

A mitigation measure normally required by the BWSC is the use of a system for retention and timed release of the sanitary waste. Such systems are required by the Commission for all new developments with wastewater discharges of 10,000 gallons per day or more into the sewer system tributary to the ESI. The system entails collecting all sanitary waste in holding tanks located at below grade levels for discharge into the sewer system during periods of low tide. Tidal inflow during high tide due to broken or improperly operating tidegates contributes to surcharging of sewer lines in the waterfront area. The use of a retention tank to discharge at low tide will help mitigate any project impacts. The tank will be 123,000 gallons capacity with duplex pumping station designed to discharge 968 gallons per minute (gpm). This will allow discharge over a four hour period of low tide, as required by BWSC. A manual override of the programmable pumping controller may be installed for use during wet weather surcharging conditions if allowed by the appropriate authorities, as is discussed in Section 6.8.5 below.

Storm Water

The block bounded by High, Pearl, Purchase, and Oliver Streets is currently occupied by the Travelers Building, a Boston fire station, and three 19th century buildings; the balance of the site is paved (sidewalks, parking, plaza area, etc.). While the proposed project will affect the mix of structures and paved surfaces, the quantity of storm water for the site will be essentially unchanged. As mentioned previously, the design of the site drainage for the project will utilize as much excess capacity as is available in the separate storm drain system via the 15" storm drain recently installed along Oliver Street. This measure will serve to improve existing conditions by diverting storm flows away from the ESI.

6.8.5 Sewer System Capacity Analysis

Capacity of Adjacent Sewers

It is proposed that the sewage holding tank discharge be directed to the 12" x 18" sewer in Oliver Street. The sewer presently is used only for sanitary sewage from International Place (and for existing buildings on the project site which will be removed). International Place storm water flows are collected in a separate storm drain system. International Place discharges a peak of 350 gpm from its sewage holding tank for its Phase I buildings. The Phase II buildings of International Place are served by a separate holding tank and will not discharge to Oliver Street. Combined with the One Twenty Five High Street peak flow of 968 gpm, a total of 1,318 gpm sanitary sewage would be discharged to the Oliver Street line during tank discharge periods. The 12" x 18" line has a capacity of

approximately 2,250 gpm based on its size and slope.* Note that the average and peak discharge flows to this sewer are the same (when discharge is occurring) since tank storage and pumping systems are involved.

Since this 12" x 18" combined sewer in Oliver Street only serves the block between High Street and Purchase Street, there is no other development expected that would discharge sanitary sewage to this line. Therefore, there will not be any cumulative effects of other projects on the Oliver Street sewer.

East Side Interceptor

The analysis of the capacity of the BWSC sewer system to handle project demands on a larger scale is a somewhat more complex issue. The local BWSC sewer in Oliver Street adjacent to the project site has sufficient design capacity to handle the design sanitary sewage flows from the project and the other user of this sewer (International Place) as demonstrated above. However, the existing major sewer interceptor (ESI) which handles the downtown Boston and harborfront area has well documented dry and wet weather capacity issues. Combined sewer overflows and surcharging conditions, especially with wet weather or high tides, have been documented.

The new ESI is presently scheduled for completion sometime in 1989 or 1990, and is expected to be fully operational by the time One Twenty Five High Street is occupied. The new ESI is being designed to completely eliminate dry weather overflows to the inner harbor and also to reduce wet weather overflows. This will improve the current water quality situation in the inner harbor.

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* Slope = (14.5' - 12.0')/250' = 0.01 ft./ft.
From Metcalf & Eddy, Wastewaster Engineering, 1972 pp. 56-71., egg shaped sewer, hydraulic radius - 0.193 x (18"/12") = 0.29 ft.,
Area = 0.510 $(18/12)^2$ = 1.15 ft^2.,
Capacity = (1.486/0.015) x (0.29) 2/3 x (0.01) 1/2 x 1.15 $ft.^2$ x 7.5 gal/cf x 60 sec/min = 2,250 gpm

Allowance for current and potential future growth in sanitary flows has been incorporated into the design of the new ESI so that the system will have adequate capacity into the foreseeable future. Major existing and planned projects such as Rowe's Wharf, 225 Franklin Street, and International Place are included in the overall scope of the sanitary flow design allowances for the new ESI. The design capacity for the new ESI in the vicinity of the project area will be about 43 mgd (million gallons per day), compared to the current estimated 5 to 9 mgd for the existing ESI. Based on the significant design efforts undertaken by the BWSC, there is no question that the new ESI will have more than ample capacity to serve One Twenty Five High Street and other major new developments under dry weather conditions. This is particularly true given the sewage holding tanks incorporated in most recent projects.

Due to the design margins for the new ESI, the design of the new regulator structures can also reflect allowances for larger discharge flow rates to the ESI than with the current system. These design margins should normally allow the interception of most or all of the combined sewer flows during wet weather conditions. The quantity and frequency of overflows via the CSOs should thus decrease signficantly with the new ESI and associated system.

However, it appears that there still will be occasions when the wet weather overflows will occur even with the new system. The potential frequency and impacts of these conditions are very difficult to estimate in a meaningful or quantitative way. Even for the existing system, the BWSC does not maintain any type of continuous flow data for individual CSOs in the project site area.

However, the BWSC and the MWRA do intend to continue to pursue implementation of CSO mitigative strategies as needed, such as installing CSO treatment facilities, to meet water quality goals for the inner harbor.

Since wet weather surcharging is currently a significant problem with the existing sewer system, and will not be completely eliminated by the construction of the new ESI, the project has established a design goal of limiting any net additional flows to the combined sewer system under wet weather surcharge conditions. The following methods will be pursued to achieve this design goal:

- o The design of the site drainage for the project site will utilize as much excess capacity as is available in the separate storm drain system via the new 15" storm drain on Oliver Street. Since the project's peak sanitary discharge is estimated to be about 18% of the peak combined flows, providing separate storm drainage for about 22% of the 2.5 acre project site would completely offset the sanitary sewage pumping rate from the project under typical storm sewer design conditions. If this is possible, then the project will have no net effect on the frequency of wet weather combined sewer overflows under storm sewer design conditions.

- o A manual override on the programmable, tidal clock pumping controller for the sewage retention tank will be provided if allowable by appropriate City and State authorities. If wet weather surcharging conditions are being experienced during the normal low-tide pumping cycle, the building managers and staff may be able to override the normal pumping cycle and discharge the sewage during the next low tide. This is possible since the tank is sized to hold a normal workday's sewage and the pumps are capable of discharging the full tank capacity during a four hour period around the low-tide cycle. This would mean that the project may not contribute sanitary flows to the ESI during the peak storm flows. This would represent an improvement over the existing situation.

- o If a precipitation event continues or occurs over two consecutive low-tide cycles or at the end of a normal workday during a low-tide, then the tank would need to be emptied. However, project sewage discharge during a number of wet weather overflow conditions could be eliminated with this mitigation measure. Most of the more intense, downpour type rainfall episodes in Boston are for relatively short duration, or at least are significantly reduced in magnitude 12 hours later. It is not practical to design a sewage holding tank for more than a one-day detention, since anaerobic decomposition conditions could develop with various unacceptable impacts including odors.

- o Investigation of other means of attenuating site storm water flows, including the use of regulators in the building roof drainage system, will be pursued during project design.

Implementation of these mitigation measures should reduce or eliminate any potential impacts the project could have on wet weather surcharging conditions in the BWSC system.

6.8.6 Mitigation Measures

Project-Specific

The following mitigation measures will be implemented by the project proponent:

- o Use of the latest, most efficient plumbing fixtures including limited flow faucets (.75 gpm vs 1.5 gpm) and toilets.

- Separation of project storm sewers with use of all available capacity in the 15" separate storm sewer on Oliver Street. Investigation of innovative techniques such as storm water retention on building roofs, with slow weeping discharge to attenuate storm peaks.

- Use of a sewage retention tank with increased capacity. The tank will be equipped with a duplex pumping system and a programmable tide clock controller. Sanitary wastewater will be pumped into the combined sewer system only during periods of low tide. This will reduce loads on the system during high tide periods when surcharging caused by tidal inflow is a problem.

- Manual override of the programmable pumping controller on the sewage retention tank for use during wet weather surcharge conditions if allowable by the appropriate authorities.

- Drainage from the underground parking garage will be treated for oil/gas removal prior to discharge.

- In addition to these measures, the proponent is prepared to operate the programmable pumping system on a feasible schedule proposed in the future by the BWSC. This could include time of day pumping to avoid peak daytime flow periods.

System-Wide Measures

Constraints imposed upon individual new developments can mitigate localized problems and can assist in achieving overall improvement to water quality in the Harbor. However, system-wide improvement can only be accomplished with large-scale

efforts to upgrade the combined sewer system operation. The MWRA and BWSC are currently undertaking a number of such improvements:

1) Replacement of the ESI. This project will be completed by the end of 1989. It will increase the ESI capacity in the site area from the current 5-9 million gallons per day to 43 million gallons per day. It will eliminate the hydraulic constraint currently causing surcharging in the vicinity of Central Wharf (BOS-060). It is also expected to eliminate dry weather overflows and reduce wet weather overflows at all the combined sewer overflow outlets that would be impacted by the project.

2) Inspection and maintenance of tidegates and regulators. The BWSC instituted a program to inspect all tidegates and regulators at least two times each quarter.

3) Completion of the CSO Recommended Plan. This comprehensive program includes the installation of new CSO treatment facilities for screening and disinfecting CSO discharges, replacement of tidegates and regulators, sewer separations, and storage facilites. The goal of this 10-year program is to eliminate dry weather overflows and reduce the discharge of untreated CSO by 75 percent.

4) Upgrade Deer Island Treatment Plant pumping capacity and add secondary treatment capability.

6.8.7 Other Utilities

Water

The water distribution system in the vicinity of the project site is shown on Figure 6.8-2. This system includes high pressure service lines for fire protection, and low pressure service lines for domestic water use. There is a loop of high pressure service mains around the site. This loop includes a 24" main and a 12" main along High Street, a 12" main along Purchase Street, an 8" main along Pearl Street, and a 10" main along Oliver Street. There are existing fire protection connections leading onto the site at High Street, Pearl Street, and Purchase Street.

Domestic water service to the site is provided directly from a 16" low pressure main that runs along Pearl Street, with a 10" main along Purchase Street and a 12" main along Oliver Street. Domestic water service to the project will be provided by connections to one or more of these mains. Concerning capacity, hydrant tests conducted in 1983 on the low service at Purchase and Pearl showed a flow of 2,140 gpm at a residual pressure of 30 psi. Improvements to the system have been made since 1983 which provide for increased capacity. As an indication of the effectiveness of these improvements, similar testing at Broad and Wendell Street on a 12" line indicated an increase from 1,510 gpm at 31 psi to 3,480 gpm at 52 psi in the same time period. A hydrant test will be conducted at the Purchase/Pearl hydrant to verify capacity at the project site.

The high pressure service system in the area has a capacity of 5950 gpm at 20 psi according to a hydrant test conducted at Broad/Wendell in 1986. The estimated fire flow for this project is 1500 gpm. Design of the fire protection systems will be coordinated with BWSC and the City Fire Department.

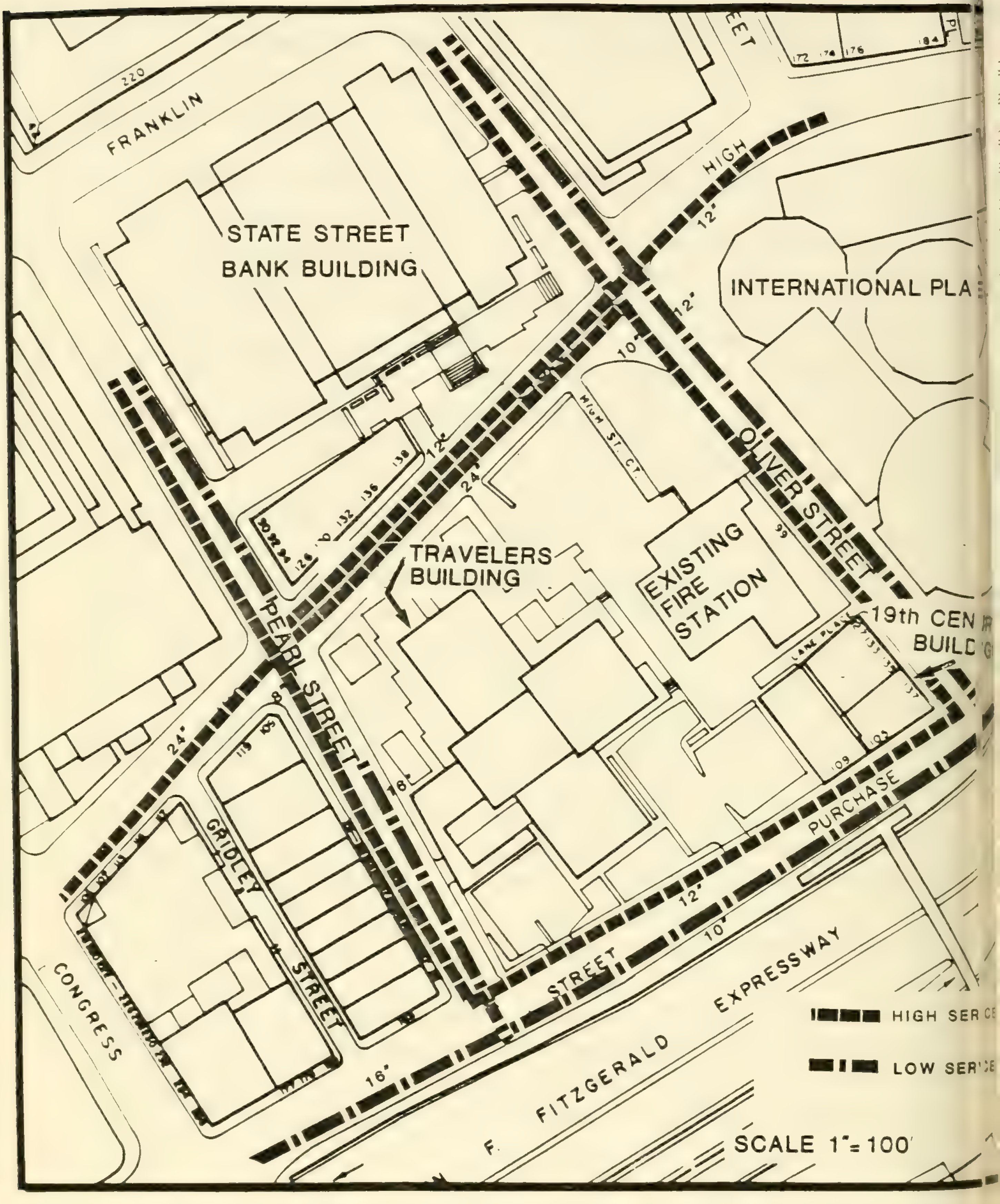


FIGURE 6.8-2 SITE AREA - EXISTING WATER SYSTEM

Domestic water demand is expected to be a total of 134,600 gpd. In addition, air conditioning makeup water is expected to average 140,000 gpd during summer months with a peak of 170,000 gpd. The peak domestic use is expected to be 236 gpm, based on a peaking factor of 3.0 for restaurants and 2.4 for offices and retail. Added to the peak air conditioning makeup of 118 gpm, a total peak demand of 354 gpm is anticipated. Available information indicates the low pressure service mains have ample capacity to satisfy this demand.

Solid Waste

With full occupancy of One Twenty Five High Street, solid waste generation is estimated to be 6-8 tons per business day. Solid waste will be picked up and disposed of by private haulers (as is the case with other office buildings in Boston).

6.9 ENERGY

6.9.1 Introduction

The primary objectives in selecting energy systems for One Twenty Five High Street are as follows:

- o To minimize building energy demand.
- o To minimize wasteful elements of summer solar gain.
- o To minimize on-site fossil-fuel consumption.
- o To maximize energy efficiency based upon the anticipated life-cycle costs of the building energy systems.

These objectives have been significant considerations in the design of One Twenty Five High Street. The energy systems include an HVAC and mechanical systems that incorporate advanced technology in energy conservation technology which meet or exceed the Massachusetts State Building Code Provisions requirements for energy consumption and other accepted industry standards such as ASHRAE 90-75.

6.9.2 Building Energy Conservation Measures

HVAC Design Considerations

The proposed HVAC system will use electric resistance for heat. Electric resistance is being used more and more frequently in Boston's commercial developments. The selection of electric heat was based upon its demonstrated reliability, its lower capital cost, and its reduced space demands. Such systems have minimal maintenance problems. An all electric development will receive the benefits of a lower electric rate,

not only for the space heating, but for total electrical consumption. An all-electric system does not require on-site burning of fossil fuel for regular heating. This not only saves on the consumption of natural gas or oil, but also has environmental benefits of not having to contend with exhaust fumes of fossil fuels.

Window Design Treatment

The window design treatment was based on projected building use. Window systems which conserve energy by limiting infiltration and by discouraging improper window use are under consideration. The windows to be used will be double glazed. The double glazing concept doubles the R values above single glazed windows, which in turn leads to conserving energy devoted to space heating and air conditioning, in winter and summer respectively.

Lighting

Efforts have been made to minimize lighting requirements. The lighting for the building will consist primarily of overhead space lighting with a minimal amount of direct and indirect specialty lighting for special tenant needs and public areas. The space lighting will be provided by the newest high-efficiency parabolic-louvre light fixtures with high efficiency ballasts. These lights combine the high efficiency of fluorescent lighting with the no-glare diffusion of a parabolic reflector returning the "wasted light". This lighting system, in conjunction with the natural lighting, requires a low wattage per square foot, far below the maximum permitted by the Massachusetts energy code (less than 3 watts/ft^2), to provide a comfortable lighting level.

All space lighting will be activated by local switching systems on a room-by-room basis.

6.9.3 Characteristics of the Selected HVAC System

The all-electric HVAC system for One Twenty Five High Street consists of the electric resistance heating, a chilled water air-conditioning system, and a variable air volume (VAV) ventilation system.

Electric resistance heat will be supplied primarily via coils in the VAV system. Supplementary perimeter electric heating will also be provided and distributed overhead through a perimeter linear diffuser. In the office and retail spaces, all heat accumulated in the ceiling return-air plenums from lights and other electrical and mechanical systems will be circulated to heat the building perimeters.

Each floor will have a separate chilled water air-handling unit serving zoned VAV fan powered units for the floor areas on the building perimeter and VAV terminal units for the building interior floor areas. The VAV equipment balances the need for outside air with recirculated inside air. Outside air will be vertically distributed to the fan rooms on each floor.

A less energy intensive condenser water-free cooling system will be provided for a portion of the cooling season. The condenser water free-cooling cycle will save energy as refrigeration compressors can be shut down when outside temperatures in the spring and fall permit natural cooling. During these periods, chilled water will be obtained directly from the cooling towers without the use of mechanical refrigeration.

The zoned VAV system has distinct advantages over conventional HVAC systems. It provides for local climate control on demand. It incorporates natural heating and cooling by mechanically mixing and supplying air volumes to areas with heating or cooling requirements. The result is an HVAC system in which the relationship between building occupancy and climate control energy consumption are quasi-linear; that is, the system can respond efficiently to localized demands whether they be special type occupancy or just partial occupancy.

6.9.4 Total Energy Demand

Since One Twenty Five High Street is an all-electric design (with an emergency back-up generator) its energy consumption is measurable. The estimated total annual energy consumption range is 20-22 kilowatt hours/square foot.

6.9.5 Conclusions

As a result of the proponent's commitment to energy conservation measures, the One Twenty Five High Street mechanical systems are well-designed and energy efficient. The major energy consuming facilities that have been chosen are a coordinated all-electric design that exceed accepted building codes and industry standards for energy efficiency.

6.10 HISTORICAL LANDMARKS

6.10.1 Project Area

The project area consists of five buildings including a City of Boston fire station within a block bounded by High Street (north), Purchase Street (south), Oliver Street (east), and Pearl Street (west). The site does abut the Richardson Block listed on the National Register of Historic Places. Buildings that currently stand within the project area are:

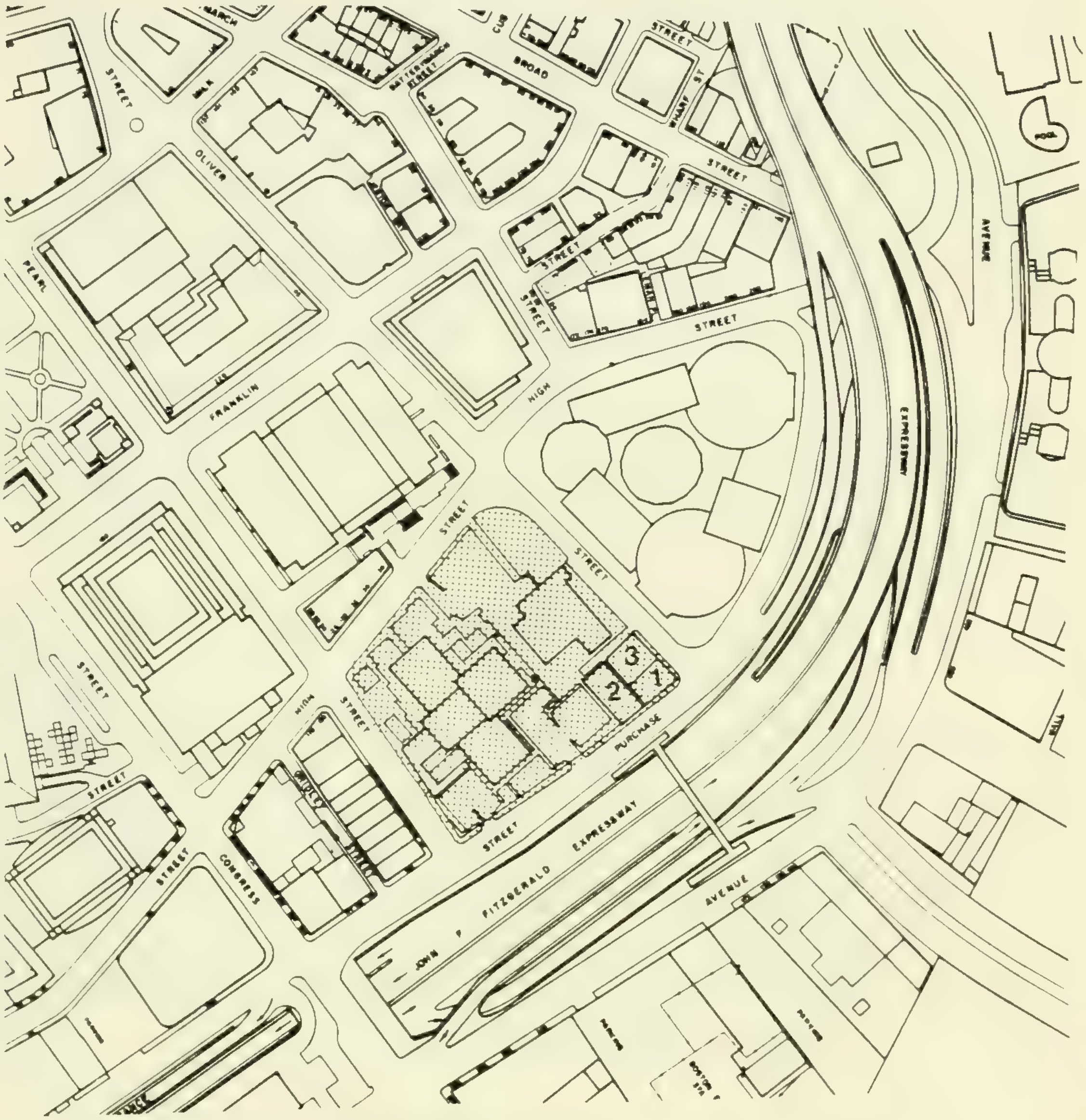
A. Travelers Building (constructed in 1958) -- A sixteen story building on the western portion of the site.

B. City of Boston fire station -- A 2-story building fronting on Oliver Street which will be relocated to a new facility on the site to front on Purchase Street.

C. Three connected, four- to six-story brick buildings (post 1880), fronting on Oliver and Purchase Streets formerly used for commercial and manufacturing purposes. These buildings will be retained and renovated.

The Boston Landmarks Commission surveys and rates buildings on their historical merit. These ratings range from 1, the most significant, to 5, the least important. The ratings of the three historic buildings to be renovated at the One Twenty Five High Street site, shown on Figure 6.10-1, are as follows:

- Building 1 (105 Purchase Street) -- This building is at the corner of Purchase and Oliver Streets. According to the Boston Landmarks Commission, the building of brick and stone is architecturally significant as a fine, intact example of simple, late



Site
Building 1 (105 Purchase St.) - Rating Group 4
Building 2 (109 Purchase St.) - Rating Group 5
Building 3 (127-133 Oliver St.) - Rating Group 3

FIGURE 6.10-1 HISTORIC BUILDINGS ON-SITE

Victorian mercantile building. The structure is located on what was originally Fort Hill in the post-fire center of metal and hardware trades. The architect was John R. Hall.

The Boston Landmarks Commission rates this building in Group 4 -- indicating that it is a "notable" building and "important to the character of the particular street, neighborhood, or area". However, buildings in Group 4 are not considered significant enough to be designated as Boston Landmarks or to be listed individually in the National Register of Historic Places, or State Register of Historic Places.

o Building 2 (109 Purchase Street) -- This building faces Purchase Street and adjoins 105 Purchase Street. The brick and stone building is in fair condition. This mercantile structure is not a distinctive example of its type, but does contribute to the streetscape by its scale and massing. The building is located in the center of the post-fire metal and hardware district. The building is associated with the printing trade. John R. Hall is listed as the architect.

The Boston Landmarks Commission rates this building in Group 5, indicating a "minor contribution to the streetscape". Buildings in Group 5 are not considered eligible for designation as Boston Landmarks or for individual listing on the National or State Register of Historic Places.

o Building 3 (127-133 Oliver Street) -- This building faces Oliver Street and is closest to the existing fire station. This building is architecturally significant as an example of Boston's fine late Victorian style. Its historical significance stems from its location at the center of the metal and hardware trades. The building is constructed of brick and stone and is deteriorating badly. The architect was George H. Young.

The Boston Landmarks Commission rates this building in Group 3, indicating that it is "significant to the City of Boston". Buildings in Group 3 are eligible for individual or district listing in the National Register of Historic Places.

Archaeological -- Discussions with the Massachusetts Historical Commission indicate that the site for One Twenty Five High Street sits on the edge of Fort Hill, part of the historic peninsula. Past filling and construction on the site has substantially disturbed the area. Therefore, it is doubtful that significant archaeological resources exist on the site. No such resources were discovered during construction on adjacent parcels.

6.10.2 Environs of Project Area

Historically, the project area stands at the southeastern edge of Boston's financial district. The visual and physical continuity of the site with surrounding districts has been largely disrupted by modern intrusions. South and east of the project area historic street patterns have been disconnected by the Central Artery and its ramps which also brought about the demolition of numerous blocks of commercial buildings and warehouses. The Customs House District and the Faneuil Hall Marketplace lie Northeast of the project area. The site abuts

Richardson Block to the west. North and west of the site, the historical context of the commercial district has been largely eliminated by the replacement of nineteenth-century row buildings with modern high-rise office buildings.

Within the southeastern segment of the financial district, there are 9 historic properties and 2 districts (see Figure 6.10-2).

1. Old Federal Reserve Bank Building (1922) (Boston City Landmark) -- The structure is important because of its interior spaces, the main banking lobby, and the members court.

2. Northern Avenue Bridge -- Has been determined to be eligible for the National Register.

3. United Shoe Machinery Building (140 Federal Street - Boston City Landmark and National Register) -- Built in 1929 as one of the city's largest skyscrapers from plans by Parker, Thomas & Rice, the United Shoe Machinery Building is significant both for its historical associations with Massachusett's extensive shoe industry and for its elaborate Art Deco design, ziggurat massing and well-preserved architectural detail.

4. South Station Headhouse (Corner Atlantic Avenue and Summer Street - National Register) -- Built in 1896-1899 and altered by the removal of its flanking wings during the 1970s, South Station derives historical significance from its well-executed Classical Revival style design (Shepley, Rutan & Coolidge, architects; Norcross Brothers, builders), its historical associations with the development of passenger train lines and several innovations in the planning of railroad terminals. The scale of the

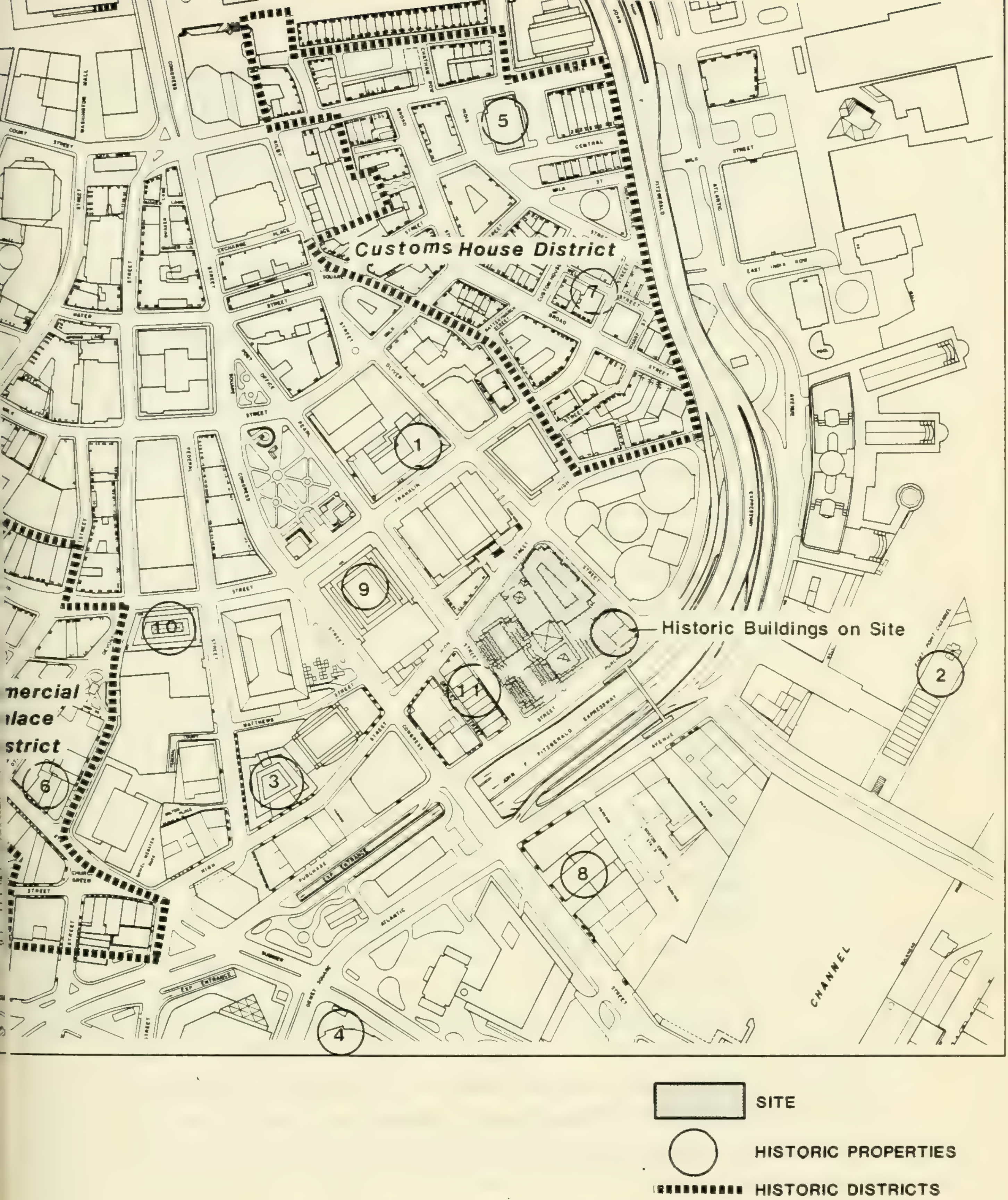


FIGURE 6.10-2 HISTORIC RESOURCES

ONE TWENTY FIVE HIGH STREET

Jung/Brannen Associates, Inc. Architects and Planners — One Twenty Five High Street Limited Partnership

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building as well as changes in the surrounding area leave it as a free-standing monument that is visible but separated from the project area by a high-rise office building (Dewey Square Tower) and the Central Artery.

5. United States Custom House (South side of State Street between India Street and McKinley Square - Boston City Landmark) -- Designed by Ammi B. Young and erected in 1837-1847. As originally built, the building was a prime example of Greek Revival Style. It was a 2-story over elevated basement granite ashlar structure with Giant Doric peristyle and porticos and a Roman Saucer Dome. In the alteration of the building, the dome was removed and a 16-story office tower was constructed. The building is currently being surplused by the General Services Administration.

6. Commercial Palace District (Addresses on Bedford, Chauncy, Devonshire, Franklin, Hawley, Lincoln and Summer Streets - Determined eligible for National Register Listing) -- The Commercial Palace District is an irregularly shaped area that contains 60 commercial buildings constructed shortly after the Great Fire of 1872 destroyed a large portion of Boston's business district. In the reconstruction that followed the fire, the majority of the district was developed with masonry row buildings constructed to five and six story heights with mansard roofs. Ornamentation was limited to facades that were frequently faced with sandstone, marble or granite in a variety of mid-Victorian architectural styles.

7. <u>Customs House District</u> (Roughly bounded by Chatham Street, the Central Artery, Batterymarch, Banks Alley, State Street, Fanueil Hall Square, and High Street) -- The area near the development site contains primary class B and class C office space, luncheon spots, bars, small retail stores, and parking lots and garages. The district is an example of mixed commercial architecture reflecting Boston's development as a major mercantile city.

8. <u>Russia Wharf Buildings</u> (518-540 Atlantic Avenue and 270-290 Congress Street - National Register) -- Built in 1897-1898 and designed by different architects for the same owner, the Russia Wharf Buildings consist of three 7-story structures that derive historical significance from their Classical Revival style architecture and their associations with the continuous commercial use of the Russia Wharf from the eighteenth century.

9. <u>The Telephone Company Building</u> (185 Franklin Street) -- Meets National Register criteria. The building is a limestone and polished mauve granite skyscraper in Art Moderne style. Its varied skyline contributes in a major way to the streetscape. It is historically significant as the headquarters of a major public service company.

10. <u>75 Federal Street</u> -- Meets National Register criteria. Significant as one of the most elaborately decorative Art Deco skyscrapers remaining in Boston, as a building which retains much of its fine period lobby interior, as an exceptionally fine office building design by a specialist in bank architecture, and as a building which reflects the new setback legislation which changed the scale of downtown Boston.

11. Richardson Block (1873 & 1885 William G. Preston, Architect) -- A group of rare marble-faced, post-fire buildings which form the only Neo-Greco commercial block remaining in the financial district. Important also as an early work by the eminent Boston architect William Gibbons Preston, and as a block which housed the leather trade. Listed in the National Register.

6.10.3 Impact of Project

Primary Impact

The primary impact of the project will occur within the block that constitutes the project area where selective demolition and new construction will take place. The following actions are proposed:

- The three post-1880 fire connected buildings at the corner of Purchase and Oliver Streets will be retained and renovated. The buildings at 105 Purchase Street and 127-133 Oliver Street, rated 4 and 3, respectively, by the Boston Landmarks Commission, will be leased for retail and office uses. The building at 109 Purchase Street, with the lowest Boston Landmark's rating of 5, will be leased for office use on the upper floors, and to the City of Boston for an ambulance facility at ground level.

- The current Travelers Building will be demolished.

- The existing fire station will be razed after a new one is constructed at a new location on the site fronting on Purchase Street.

- New construction will include a 30-story building and a 21-story building which will be connected by a three- to nine-story infill base building. The renovated 19th century buildings will also connect with the infill base building.

In summary, the project has been designed to mitigate the effects of new construction on historic resources within the project area.

Secondary Impacts

As construction will be limited to the project area and is not part of a larger plan requiring the construction of streets or surrounding blocks, the project will have no direct effect on nearby historic properties. Its principal effect on such properties will be visual; the importance of this effect will vary with distance from the project area.

Historic properties nearest the site are the Old Federal Reserve Bank building, the Telephone Company building, Customs House District, and Richardson Block. In the case of the Old Federal Reserve Bank building, the State Street Bank, at 475 feet, stands between the Federal Reserve Bank and One Twenty Five High Street; thus, little visual impact will occur. The Telephone Company building lies northwest of the project site.

The Customs House district to the northeast will be partially blocked by International Place, under construction adjacent to the project site, and the new mid-rise building at 265 Franklin Street.

The historic Richardson Block abuts the project site to the west and faces the Pearl Street entrance to One Twenty Five High Street. The historic buildings on the site and on the adjacent Richardson Block have had an important impact on project design. The proponent's intent is to incorporate the three renovated 19th century buildings into the overall design of the project, giving particular attention to integrating cornice lines and

setbacks in the new construction. Key alignments in the new buildings will relate to the cornice lines of the three 19th century buildings and to the Richardson Block. In particular, the project's 5-story base is designed to reflect the cornice lines in the area (see Figure 4-22). The scale breakdown of the new structure is designed to be compatible with the historical buildings, including the Richardson Block (see Figure 4-24). These visual relationships were an important element in the design of the project and its contextual fit with existing buildings.

The project design seeks to re-establish the historical streetscape by building predominantly to the property lines for the first five stories. Above this level, the expression of three building masses rise to distinctive building tops. The 30-story structure is characterized by numerous setbacks, placing it in character with many of Boston's most elegant high-rise buildings. As a practical matter, the design cannot accomodate further setbacks due to requirements for an adequate lobby inside the new Telephone Company building, space for the fire station, public pedestrian ways, and the required 3 lanes of garage access.

The remaining historic properties and districts discussed in Section 6.10.2 will not be disturbed by the construction and operation of One Twenty Five High Street.

REFERENCES FOR HISTORICAL SECTION

Boston Historical Commission (FILES)
80 Boylston Street
Boston, MA

Boston Landmarks Commission (FILES)
City Hall Plaza
Boston, MA

6.11 DESIGN AND AESTHETICS

6.11.1 Site History

Boston has a rich history of physical development. It is a city composed of many strongly defined districts and neighborhoods. One of its distinguishing characteristics is that each district contains examples of its architectural history since early 1800. It is precisely this living sense of history that helps to give each district its own unique character. The Financial District is particularly unique; its history goes back to the beginning of the Commonwealth and before, to the early colonial settlement.

When the Town of Boston was founded in 1630, Fort Hill was a central feature of its geography. The Hill, one of three great hills of the Town, dominated Boston's South End, and was used as fortification against invaders from the sea. Through most of the 17th and 18th centuries, it served as a pasture and common land. The fortification was strengthened at the time of the Revolutionary War.

In the early 1800's, the area was occupied by residential structures and became known as one of Boston's finer neighborhoods adjacent to the colonial shoreline. Fashionable houses and two schools surrounded a park. During the 1840's, the area entered into a period of marked transition lasting about 25 years. The growth of Boston's commerce pressed upon the neighborhood and it gave way to business uses. Residential landowners moved out, but held their properties for future sale. A good deal of the property was converted to rental and the general neighborhood character suffered. Health conditions became a problem and the City began razing the houses and leveling Fort Hill to fill in the waterfront between nearby wharves; thus Atlantic Avenue was created. By 1870, Fort Hill was leveled to near its present grade, and construction of other commercial properties to serve the retail and wholesale trades

ensued. Very little of this historical character remains today. Most of it was destroyed by the Great Fire of 1872; however, the Broad Street Historical District serves to preserve the highest quality buildings of the Fort Hill commercial history.

The present character of the Financial District began taking shape after the Great Fire, when the area was rebuilt with mostly red brick buildings four or five stories high. The next generation of buildings, beginning around 1912, included the Custom House Tower and the United Shoe Machinery Building, which was completed in 1926. These early 20th century buildings, typically 12 to 24 stories high, used buff brick, limestone and granite, and in some cases, cast stone, as facing materials.

6.11.2 Design Concept

One Twenty Five High Street is designed to harmonize with the design philosophy exemplified by the remaining examples of the buildings just mentioned. This harmony establishes a sense of belonging, a sense of continuity in the historical develoment of the Financial District. One Twenty Five High Street will be in character with the Boston skyline by building upon historical precedent. This is accomplished by relating the three fundamental components of building elevations -- the bottom, middle, and top -- to the specific site and district context. The project seeks to create a Boston experience for the pedestrian, while at the same time creating protection against the environmental inconveniences of rain, snow, and wind. This is accomplished by means of arcades and covered light-filled passages through the project.

6.11.3 Relationship to Surrounding Environment

A number of building characteristics are designed specifically to blend the project into the Boston context and enrich the district's public amenity base. They are:

o **Massing**

The location of the tallest mass, the 30-story structure, on the southwest corner of the site accomplishes several important urban design goals. First, the rhythm of taller and lower buildings in alternation along City blocks is preserved. The tallest element of the project does not press upon a neighbor. Both of the tall structures in the project have been broken into smaller masses by using notches and setbacks. This is most dramatically illustrated by the twin components which make up the 30-story building. This reduces apparent mass. In a similar but more subtle way, the 21-story structure is divided into three components along its longest sides.

The new construction wraps around the three (four-, five-, and six-story, respectively) 19th century brick buildings, at the corner of Oliver and Purchase Streets, which will be renovated and preserved. The 21-story structure sets back over 40 feet from the three old buildings along Oliver Street. This setback is filled by a 3-story enclosed skylighted entry courtyard, which will face the International Place main building entry across the street. The skylighted courtyard also extends along the southwest side of the older buildings leading to an entry into the project on Purchase Street. The adjacent new construction rises five stories to match the parapet of the old structure and then steps back up to nine stories in height. The terraced massing and the courtyards, when combined with the break-up of the street facade into small components side by side, yield a massing that relates to the older structures in its facade breakdown, both on the site and in the district.

- **Building Heights**

  At its very highest, this project will be lower than the Custom House Tower, lower than the adjacent State Street Bank, and considerably lower than the adjacent International Place. The 30-story structure will have a height of no more than 400 feet and the 21-story structure will have a height of no more than 300 feet. The remainder of the project is composed of an infill base typically five stories in height, with the portion along Purchase Street rising from five to nine stories in a series of setbacks above the fifth floor.

- **Scaling Elements**

  The project can be described as a series of buildings surrounding a common space, with the interstitial spaces between buildings providing access to the atrium at the center. This breakup of the ground plane is reinforced by the building masses. The buildings are:

  - The 30-story structure in two components.
  - The fire station.
  - The three 19th century buildings.
  - The 21-story structure in three components.

  In addition, the entries into the common area which exist on each surrounding street -- High, Oliver, Purchase, and Pearl Streets -- are denoted by their separate and distinctive architectural treatment. In this manner, each facade of the project is broken down into many components at a more comprehensible and sensitive human scale. People will be welcomed by the pedestrian scale of the arcades and the

articulation of a 5-story base by cornice lines and additional building articulation. This base also has its own bottom, middle, and top components.

Moving up above the fifth floor, the middle of the building develops a more modest level of articulation, typical of the landmarked buildings. Also, both tall structures have special, although very different expressions of top. In the tradition of many of Boston's finer buildings, the 30-story structure has many setbacks at its top, dissolving the mass as it reaches skyward. The 21-story structure is capped by a double cornice line spanning the stories; it reflects, at its top, many of the scale giving components at its base.

In addition to subdivisions of the massing just discussed, each component is further subdivided into vertical and horizontal fenestration components, primarily punched openings and vertical striping in clustered alternation.

By combining these many ways of subdividing and refining the elevations and massing of the project, the development of a city block becomes an asset to its neighborhood. When seen from a distance, it becomes distinctive, but not dominating or overwhelming.

- <u>Materials</u>

The project will use a variety of materials including glass, granite, metal panels, and perhaps cast stone or limestone. In an attempt to better understand the nature of materials in the Financial District and adjacent districts, an extensive study of materials

used in the Downtown was conducted. The choice of materials for the project will be compatible with the other buildings on surrounding blocks.

- <u>Open Spaces</u>

  One Twenty Five High Street is characterized by a large number of open spaces which will add considerably to the public amenity base in the Financial District and Boston's Downtown.

  - Arcades -- The project is surrounded on three sides by pedestrian arcades which vary in height from one to two stories and offer an expanded sidewalk and protection from inclement weather.

  - Building Entries/Entry Courtyards -- There are four main public entries into the common area, one on each street, each with its own unique character and open space. The main public entry on High Street has an extensively landscaped fore-court before entering the barrel vaulted interior walk to the atrium center. The Oliver Street entry with its 3-story enclosed skylighted courtyard was described earlier, as was the Purchase Street entry. The main entry on Pearl Street enters into a 2-story passage, crossed by bridges on the second floor, to the atrium center. This passage splits the two commercial building elevator lobbies of the 30-story building -- one for multi-tenanted space and the other for the New England Telephone and Telegraph Company.

- Atrium Center -- The focal point of the internal open space of the project, at the confluence of the public entries, is a 10-story, landscaped, skylighted atrium courtyard.

o <u>Site Improvements/Amenities</u>

The ground levels and pedestrian environment of the site will be carefully developed to include a number of public enrichment features.

- Arcade Paving -- The arcades will be paved in a pattern to reinforce their column modules and bay rhythms.

- Lighting -- The sidewalks and arcades as well as the interior open spaces and building elevations and tops will receive lighting treatment designed to enhance public safety and highlight primary architectural features.

- Landscaping -- Exterior and interior areas will be landscaped with plantings and trees.

- Street Furnishings -- Planted areas dispersed throughout the project will be raised in beds to provide seating at their periphery. Additional benches will be installed in the atrium and at the Oliver Street entry.

- Sidewalks and Curb Cuts -- The project will include construction of new city sidewalks and curb cuts on all four sides of the site, conforming to City standards.

o Land Uses

The following uses currently exist on the site:

- Office
- Fire Station
- Parking on Grade

The following uses will be included in the proposed development on the same site:

- Office
- Fire Station
- Ambulance Facility
- Parking Below Grade
- Retail and Possibly Restaurant

6.12 CONSTRUCTION IMPACTS

Construction at One Twenty Five High Street will involve renovation of the 19th century buildings and ambulance facility, building of a new fire station, demolition of the existing fire station, demolition of the existing 16-story Travelers Building, erection of the 30-story building and erection of the 21-story building. Major construction impacts will result from demolition activities and erection of the major new buildings.

6.12.1 Demolition

This will take approximately six months, with the major effort involving the removal of the existing Travelers Building. At this time, two methods of demolition are being considered. One is implosion and the other is by use of a crane and wrecking ball. Both methods and their probable impacts are described below.

Implosion

Implosion, which involves the use of relatively small quantities of shaped explosives detonated in a precisely timed sequence, has been successfully used for several major Boston demolition projects. Examples include the Madison Hotel near North Station and the Parking Garage that was formerly on the International Place site.

Strict safety procedures will be observed and applicable regulations will be followed in preparing the structure for demolition. The implosion itself will be scheduled for a Sunday when traffic and business activities are at a minimum. Appropriate and early warnings will be posted and announced in preparation for the implosion.

The controlled explosions will be of very short duration. The immediate vicinity will be sealed off for safety purposes. The implosion will likely cause relatively large amounts of dust that will settle in the immediate area. The dust will be visible on nearby buildings, parked cars, vegetation and streets and sidewalks. The demolition contractor will make arrangements for appropriate cleanup of the affected area. The particulate matter or dust will be from plaster, concrete and mortar. Any hazardous materials which may be within the current building will be removed prior to the implosion in compliance with applicable statutes and regulations.

Within the several weeks following implosion, the debris will be loaded on dump trucks and removed to be used as fill or placed in an offsite landfill. Any structural elements that may survive the implosion will be demolished with conventional demolition equipment and likewise removed.

The likely impacts during the demolition phase will affect noise, air quality and transportation. These are discussed in more detail, in each of the subject chapters.

Mitigation steps during the demolition phase include:

- Noise - The Sunday implosion will dramatically reduce the possibility of sensitive receptors to the blast noise as most offices will be empty. Warnings to persons in the area will reduce the potential for people to become alarmed at the blast noise itself. Beyond that, the effect of demolition will be relatively minor.

- Dust - Spraying of dust-producing debris immediately following the blast will reduce the amount of fugitive dust. Street cleaning equipment will be deployed immediately following implosion as would clean up of sidewalks, nearby cars and other areas where heavy dust may settle.

- Traffic control - as provided for in the Access Plan to control the entry and egress of trucks removing debris to minimize disruption of traffic. The Central Artery will have to be closed for a period of time. Detours will be suggested to minimize traffic congestion.

Crane and Ball

The crane and wrecking ball technique is a more conventional approach than implosion. The building is prepared in much the same manner as it would be for implosion. The wrecking ball systematically strikes the main structure as sections of steel are broken off. The crane is used to strike the ball against the building and also to drop sections of steel and loosened mortar to the ground below. Again, strict safety procedures will be employed, such as sealing off the area from pedestrians, fencing in the construction site and meeting applicable safety regulations.

The likely impacts of the conventional wrecking procedure will affect noise and air quality. These are discussed in more detail in each of the subject chapters.

Mitigation steps during this phase include:

- Noise - The crane and wrecking ball procedure produces noise both in striking the building and dropping debris to the ground. Some mitigation can occur if the debris is lowered close to the ground before dropping it.

- Dust - Dust-producing debris will be sprayed to reduce the amount of dust in the immediate area.

6.12.2 Construction of the 30-Story Building

This will take approximately 30 months. The following activities will take place:

- Excavation - This will take approximately 4 to 5 months. Excavation will go down to approximately 6 floors or 70 feet. Heavy, earth-moving equipment such as heavy dump trucks, hydraulic and large front end loaders, and backhoes will be used. Perimeter boring tests have indicated that there will be no need for blasting to remove large rocks. If smaller rocks appear during excavation, they will be broken up and removed by mechanical means rather than blasting. The major impacts during this period will be noise from the heavy equipment, some dust from excavation activities and traffic from trucks moving into and out of the project site.

- Foundation - This will also take about 4 to 5 months. The foundation will be on spread footings. Soldier piling for earth retainage will be pre-drilled, rather than driven. There may be some miscellaneous pile driving or sheet driving as part of the foundation placement. Some noise may result from such pile driving but since most of the piles will be pre-drilled the overall noise levels will be reduced.

- Steel Erection - Core and shell will take about 10-11 months. The major impact will be resulting from pneumatic tools and other mechanical equipment. Trucks bringing in the steel and movement of the beams will generate some noise. The crane to be used is a climbing tower crane where the crane engine moves up with load. This will have the effect of moving the engine noise away from street level as the job proceeds.

- o Exterior Finish - Also about 4 to 5 months, this activity will involve installation of the building's skin. This will also require use of the climbing tower crane. Some noise and traffic impacts will result from delivery vehicles and movement in and out of the site.

Mitigation steps during the construction will include:

- o Use of mechanical means to break up and remove rocks as opposed to blasting.
- o Use of pre-drilled soldier piles as opposed to extensive pile driving, although there will be miscellaneous pile and sheet driving on-site.
- o Water spraying of dust producing debris.
- o Traffic control - as provided in the Access Plan.
- o No nighttime work is anticipated. It is expected that the project will require only one shift where most activity occurs during normal working hours during the week.

6.12.3 Construction of the 21-Story Building

It is expected that the continued construction will begin approximately 12-18 months into the first part of construction. Therefore, all construction schemes will be simultaneous for part of the time. Continued construction is also expected to take about 30 months from start to finish. The various sub-activities of construction will be repeated throughout the project, i.e., excavation, foundation, steel erection, and exterior finish.

6.12.4 Other Construction Impacts

Other construction activities that will take place will have far fewer impacts than the demolition of the existing Travelers Building and the construction of the two main buildings on the site. These are as follows:

- Renovation of the 19th century buildings - This will be the first evidence of construction on the site. Most of the activities will take place within the buildings and will include removal of interior debris (plaster, plumbing, fixtures, flooring and miscellaneous unwanted material). These would be typically loaded onto a dumpster at the sidewalk and periodically removed. Truck traffic will be minor and almost unnoticeable due to other construction nearby. Actual renovation will require delivery of finish products for installation (drywall, fixtures and other such building material).

- Construction of new fire station - The proposed new fire station will be located in that portion of the infill base to the 30-story structure along Purchase Street which rises from five to nine stories. The new fire station will occupy portions of the first three floors.

- Demolition of old fire station - This will take place after the new station is complete and occupied. Demolition activity will follow conventional methods of the crane and wrecking ball.

7.0 MITIGATION MEASURES

7.0 MITIGATION MEASURES

As evident from this report, One Twenty Five High Street has limited potential for negative environmental impact. This is due, in large part, to the significant amount of effort directed toward mitigation of environmental impacts which is included in the current project design.

Chapter 4 of this report describes the numerous alternative schemes for development of this site that have been evaluated over the past several years. Each successive iteration was developed to respond to specific concerns of the BRA with regard to potential impacts. The project as originally proposed reached a height of over 600 feet. The current proposal calls for a maximum height of 400 feet. This significant downsizing of the project has resulted in a concomitant reduction in potential impacts. In addition, project elements have been relocated on the site to minimize traffic conflicts and create opportunities for pedestrian amenities; heights have been reduced to minimize shadow impacts; an arcade has been provided to mitigate the existing windy environment; and the project was reconfigured to retain three historic buildings on the site. Each of these examples demonstrates the significant amount of mitigation included in the current building design, which has resulted in a project with limited potential for negative impacts.

Specific measures agreed to by the project proponent, including design changes, to mitigate potential impacts associated with this project are outlined below.

Transportation

Included as section 6.1.4 of this report is the Access Plan proposed for this project by the developer. The purpose of the Access Plan is to elicit commitments from the developer aimed at reducing the amount of traffic associated with the project.

The mitigation measures to which the developer has committed include:

- Ride sharing - encouraging use of carpools and vanpools by providing an on-site ride matching program, provision of promotional materials, and coordination with Caravan or other vanpool providers.

- Public Transportation - encouraging use of mass transit by selling bus and MBTA passes, promoting transit subsidies by building tenants, provision of bus and train schedules and other promotional material.

- Alternative Work Schedules - reducing peak-hour demands by promoting flex-time (currently in place at NET), providing off-hours building services.

- Parking Supply Management - parking spaces will be managed to reduce peak-hour trips, including preferred high occupancy vehicle (HOV) spaces and reserving spaces for off-peak arrivals.

- Delivery Vehicles - all deliveries and loading are accommodated off the street, with loading available 24-hours per day to encourage off-peak deliveries.

- Taxis - will determine a mutually agreeable taxi-stand location with the City.

- Pedestrian - pedestrian links improved around and through the site.

- Bicycle storage available.

- A transportation coordinator will be appointed on the building staff to insure success of access plan.

- Construction management will include protected pedestrian routes, police officer control as required, no construction worker parking, off-peak worker shifts.

Wind

In order to minimize pedestrian discomfort due to high existing, and future, wind levels in the project area, the following mitigation measures have been included in project design:

- Enclosed environmentally controlled atrium and retail area as opposed to the open area originally proposed.

- Inclusion of pedestal-base structures for the taller building elements to deflect downward winds.

- Provision of a pedestrian arcade around three quarters of the project to shelter pedestrians from downward winds.

Shadows

Building elements have been reduced in height and reconfigured on the site to minimize impacts to major public open spaces, particularly the proposed park at Post Office Square. In particular, the 600 foot high tower originally proposed on the northeast corner of the site has been reduced to no more than 300 feet, reducing shadow impacts significantly. In addition, the north-south cross-section of the taller building has been narrowed at its center and ends, further mitigating shadow impacts.

Daylight

Daylight impacts of the proposed project are mitigated using step-backs at the upper building elevations, and breaking up of long-block facades into several discreet building elements.

Excavation/Soil Conditions

Although no significant excavation or subsurface impacts are expected, the following measures will be taken to minimize potential impacts:

- o No continous pile driving will be undertaken. The foundation will be on pre-drilled soldier piles.
- o Lateral support will be provided by tiebacks drilled and grouted in glacial till.
- o Any pervious zones encountered during excavation will be dewatered and grouted to prevent further seepage.
- o An underdrain system will be considered beneath the lowest floor slab. If incorporated, it will be designed so that groundwater levels are not lowered in surrounding areas.

Air Quality

No air quality impacts are expected as a result of project development. However, precautions will be taken during construction to minimize demolition debris and fugitive dust impacts. These include:

- o Following safety procedures and applicable regulations in preparing existing structures for demolition.

- o Spraying dust-producing debris to reduce fugitive dust emissions.

Noise

No negative noise impacts are expected during construction or operation of the project. No pile driving is expected during construction.

Utility System

Measures to mitigate impacts to the City sewer system include:

- o Inclusion of separate storm and sanitary lines from the site to the street to accommodate future separation of flows.

- o Use of water conservation measures throughout the buildings.

- o Provision of a sewage retention tank to allow for sewerage discharge during periods of low flow in the East Side Interceptor, i.e., during low tide periods.

- o The programmable pumping system can be operated on a feasible schedule proposed in the future by the Boston Water and Sewer Commission, including time of day pumping to avoid peak daytime flow periods.

- o Manual override of the programmable pumping controller on the sanitary sewage holding tank for use during wet weather surcharge conditions, if allowable by permitting authorities.

- o Treatment of drainage from the underground parking garage prior to discharge.

Energy

The proposed project has been designed specifically to minimize building energy demands, including heating, cooling and lighting. Energy conservation measures include:

- Double glazed windows for thermal insulation.
- Use of high-efficiency lighting fixtures with local switching systems.
- Use of a variable air volume ventilation system which can balance inside and outside air volumes depending upon temperatures.
- Provision of a zoned HVAC system able to respond to local climate control demands.

Historical Landmarks

The proposed project has been reconfigured since its original design to retain three 19th century buildings of some historical interest. These are located at the corner of Purchase and Oliver Streets. These three structures, 4 to 6 stories in height, will be renovated and leased to the City of Boston for its ambulance facility, and to other tenants with uses appropriate to the project.

In addition, the overall design of the project is sensitive to nearby historic areas in its use of materials, facade treatment and architectural detailing.

Construction Impacts

Measures to mitigate construction impacts include the following:

- Safety Precautions (closing of Central Artery, sealing-off area, careful preparation of building) and warning to persons in the area if implosion is selected for demolition.

- Spraying of debris to reduce fugitive dust emissions.

- Immediate street cleaning following implosion, if applicable.

- Traffic control as provided for in the Access Plan.

- Careful preparation of existing structures according to applicable regulations prior to demolition.

8.0 RESPONSE TO COMMENTS

8.0 RESPONSES TO COMMENTS

The following sections will provide a guide to the location of responses to comments received regarding the DEIA.

Section 8.1 contains reproductions of the comments received on the DEIA. Each comment letter has been labeled with a number. In the left margin of each letter, a subsection number has been assigned to each comment within the letter. This number is utilized in Section 8.2, the Cross-Referencing Index.

The Cross-Referencing Index is a table which lists each comment number, provides a summary of each comment, and indicates the location of the response to each coment. A response is located either within the text of the FEIA or is addressed separately, in Section 8.3.

8.1 COMMENTS ON DRAFT EIA

Letter

1. Boston Redevelopment Authority

2. MA Executive Office of Transportation and Construction

3. Commissioner, Boston Traffic and Parking

4. Stephen H. Kaiser

5. Boston Fire Department

6. Boston Water and Sewer Commission

7. Massachusetts Historical Commission

8. Boston Landmarks Commission

9. Boston Preservation Alliance

10. Boston Preservation Alliance

BOSTON
REDEVELOPMENT
AUTHORITY

Raymond L. Flynn
Mayor

Stephen Coyle
Director

One City Hall Square
Boston, MA 02201
(617) 722-4300

February 12, 1987

1

Mr. Brian K. Gabriel, Director
The Prospect Company
One Tower Square
Hartford, Connecticut 06183

Dear Mr. Gabriel:

Re: 125 High Street Draft Environmental Impact Assessment Report

The Boston Redevelopment Authority staff has reviewed the Draft Environmental Impact Assessment report which you have submitted for the 125 High Street development project in downtown Boston's financial district. In accordance with the Authority's environmental review procedures, this document also has been made available for public and agency review. Our comments on the report are detailed below, and comments received by the Authority during the public review period are attached. The Final Environmental Impact Assessment should respond to these comments and should provide the additional or corrected analyses as indicated.

General/Format

In general, the DEIA has presented a comprehensive analysis of the anticipated impacts of the development of 125 High Street. However, a number of areas of the report require clarification of the information presented or additional analysis that was not included in the draft document. The Final EIA should include all the information and analyses of the Draft EIA, revised or expanded in response to the several comments of the BRA and other reviewers. In addition, the Final report should contain a copy of this letter and copies of all comment letters which have been received during the public comment period. Issues and questions raised in these comments should be addressed either separately or within the body of the report, as appropriate, and with proper references.

6.1 Transportation

Traffic

1.01 On page 6.1-10 it is stated that the 125 High Street network is consistent with the 125 Summer Street network. However, a comparison of the existing traffic volumes for each project indicates that for some intersections common to both (e.g.: Congress/High, Congress/Atlantic) volumes are significantly different. This discrepancy should be resolved in the FEIA.

JB1/I/021287/1

1.02 The most serious traffic impact of the project is likely to be at the intersection of Congress and Purchase Streets, where the level-of-service is projected to be at "F" in 1994, with a volume/capacity ratio of 1.25, in the No-Build scenario (P.M. peak hour). The volume that the 125 High Street project would add represents a significant deterioration of a projected unacceptable situation. Although roadway improvements are suggested for this (and other congested) intersections, implementation is dependent on others. The Final EIA should discuss the commitment to implement the suggested improvements.

1.03 The Massachusetts Department of Public Works (I-90/I-93 Project) has identified a number of potential conflicts with respect to the use and availability of Purchase Street, both during the construction period for the depression of the Central Artery and during long-term operation. The Department has recommended the coordination of design requirements to arrive at mutually-acceptable accommodations for both projects. The Final EIA should describe the means by which these issues are being addressed.

1.04 During the A.M. peak hour, some 3,100 vehicles would be entering Purchase Street at Oliver Street, of which 645 vehicles (or 10 per minute) would enter the garage (based on Fig. 6.1-11). In the evening peak hour, some 2,200 vehicles would be travelling on Purchase Street while 584 vehicles would be exiting the garage (Fig. 6.1-12). The Final EIA should evaluate the impact of the garage traffic (entering and exiting) on Purchase Street traffic flow and on the Purchase/Oliver Streets intersection, both during the A.M. and P.M. peak hours. Included in the analyses should be the effect of morning queuing at the garage entrance on Purchase/Oliver level-of-service.
1.05 Moreover, the impact on accessibility to and from the fire station also should be examined in the Final EIA.

1.06 A new (and presumably more accurate) methodology has been used for the intersectional level-of-service (Special Report 209, Transportation Research Board). The Final EIA should indicate whether the traffic analyses conducted by this methodology accounts for delays resulting from pedestrian traffic or conflicts at the intersections analyzed. Heavy volumes of pedestrians are projected in the direction to and from South Station (from this and other nearby projects) and Dewey Square itself experiences considerable pedestrian traffic.

1.07 The Central Artery Impact discussion (pg. 6.1-52) is inadequate. More detail analysis is needed to show the impact on Central Artery traffic, level of service, congestion, etc. of the additional traffic generated by the 125 High Street project, including capacity impacts on ramp merges and weaves and effects on adjacent surface intersections (e.g., Atlantic/Northern Ave.).

1.08 The discussion of the Dewey Square TSM Alternative B (pg. 6.1-57) should indicate the effect on LOS levels with implementation of this alternative, particularly the reversal of High Street, on the affected intersections.

1.09 In Table 6.1-27, should not the "15" under B (Vehicle Trips: A.M. in (goal)) be "215?"

1.10 The differences in volumes and V/C ratios between the 125 High Street report and the Fan Pier/Pier 4 FEIR are explained (pp. 6.1-90, 91). The Final EIA should evaluate the effect of the use of different analysis techniques on the accuracy of the future predictions (i.e., which study is the more accurate?). In addition, the Fan Pier/Pier 4 development program (Table 6.1-16) and vehicle trip generation numbers (Appendix A) are substantially different from the corresponding information in the Fan Pier/ Pier 4 FEIR. This discrepancy should be resolved in the FEIR.

Transit

1.11 The data given in Tables 6.1-2 and 6.1-3 on rapid transit capacity, headways, ridership, etc. are, in some cases, significantly different from the same data presented in the 125 Summer Street EIR. This difference should be explained (it is assumed that the ridership differences are due to use of a V/H survey rather than MBTA data).

1.12 The rapid transit impact discussion (pg. 6.1-62) should also include an analysis of the impact on the Red Line at South Station from the additional trips (background and project) which would use the Red Line to access the Green Line at Park Street.

Parking

1.13 Although the Parking in Central Boston report did state that only 16.7% of the trips generated by the Travelers Building arrive by auto (pg. C-5), this percentage was based on a 1980 Downtown Crossing survey which presumably included non-work trips as well. A later (1982) survey of employees conducted by the City of Boston indicated a significantly higher (42.9% auto use (pg. B-5). Also, the NET survey (Appendix B of the DEIA) shows only a 66%, not 78%, use of public transportation. Further justification of the use of the 30%/70% auto/transit mode split, therefore, will be required, in the light of the above data (pg. 6.1-24).

1.14 The Boston Fire Department, in their comment letter, has indicated that a minimum of 30 parking spaces will be required for fire department personnel. The DEIA states that 25 spaces would be reserved for the department. The Final EIA should present a resolution of this parking issue.

1.15 The parking analysis (pg. 6.1-70) apparently considers the 125 public spaces as long-term spaces. Should not these spaces be considered as short-term spaces, especially since it is noted in the Parking Supply Management section (pg. 6.1-79) that restrictions will be placed on the use of these spaces to promote short-term use? Thus the long-term (employee) deficit would be 320 spaces rather than 195 spaces and the short-term deficit 140 spaces, for a total deficit of 460 spaces (as noted). The City of Boston (Traffic and Parking) has expressed concern that a mix of both long- and short-term on-site parking be provided.

Pedestrian Analysis

1.16 The pedestrian LOS analysis should be included, at least in the appendix.

1.17 The Final EIA should briefly summarize the methodology used to determine pedestrian level-of-service. Does this methodology include the effects of driveways and street intersections? If not, what would be the effect?

6-2 Wind

1.18 The quantitative (hot-wire) wind impact analysis was based on a previous design for the 20-story office building. The current design is a building that is somewhat longer along Oliver Street. The Final EIA should indicate the extent of any change in wind impact, particularly in the vicinity of Oliver Street, due to the redesign of the office building.

1.19 The Wind section of the EIA does not describe the wind standards used by the BRA to evaluate the acceptability of pedestrian level winds in the vicinity of the project. These safety/comfort criteria should be included in the Final EIA together with an analysis as to whether the project meets these standards and an evaluation of the projects' impact on various forms of pedestrian activity.

1.20 The erosion study (pg. 6.2-5) indicated that sealing some of the openings in the arcade at the corner of Pearl and High Streets would be effective in reducing high flows through the arcade. The Final EIA should indicate whether this design change has been made and whether it was analyzed in the hot-wire study.

1.21 Although there seems to be good agreement between the 125 High Street wind study and the Peterka and Cermak study of International Place for locations close to the International Place project, in most instances P&C's results are higher than those for 125 High Street, in some cases substantially higher. What is the explanation for this?

1.22 With respect to seasonal variation, the report indicates (pg. 6.2-20) that winter wind speeds are close to annual speeds. However, most other wind studies in Boston have indicated winter winds to be approximately 10% greater than the annual speeds. The Final EIA should give an explanation of this difference (the other seasons compare favorably).

1.23 The results of the wind study (Table 6.2-1) show that with the 30-story building alone there would be two violations of the BRA standard (stations 8 and 13) and with full development one violation (Station 9). Therefore mitigation measures will be required (since the project is responsible for thes exceedances, which do not exist without the project). Both Stations 8 and 9 are critical locations since they are entrances to 125 High Street and International Place respectively. The Final EIA must propose measures to mitigate these excessive winds.

1.24 On Table 6.2-3 the last two columns need to be labeled.

1.25 In Appendix B-1 the photographs of the sand scour patterns are very p reproduced and impossible to read. Clearer photographs are required f Final EIA.

6.3 Shadow

1.26 The winter description of noontime and mid-afternoon shadow effects is reversed (pg. 6.3-5).

1.27 The statement on pg. 6.3-6 (para. 3) that the project would have no impact on the Custom House District is incorrect (see the following paragraph). In addition, the summary should note also the spring/fall impact on Post Office Square Park.

6.6 Air Quality

1.28 The air quality analysis indicates a potential violation of National and State standards at the Congress and Purchase Streets intersection, which could be minimally exacerbated by the project. This violation is based on the assumptions used in the analysis, which the EIA indicates would not occur were different assumptions used. Nonetheless, the values would be sufficiently close to the standards to cause some concern and the need to explore further mitigation measures. Moreover, Table C.5 in the Appendix shows that a vehicular speed of 20 mph was used to determine composite CO emission rates, but Worksheet 1 indicates a speed of 17 mph was used in the
1.29 analysis. This discrepancy should be explained in the Final EIA, as well as the effect (if any) on the resulting analysis of CO concentrations.

6.8 Utility Systems

1.30 The discussion of the sewer system does not adequately describe the existing system bordering the site nor does it indicate the adequacy of the existing system to handle loads from the project (as well as other existing/proposed (e.g., International Place) projects). No analysis has been included to determine the project impact. The Final EIA should provide this impact assessment.

1.31 The DEIA fails to mention the new 15" storm drain in Oliver Street built by the proponents of International Place, which presents the opportunity for the extension of sewer separation to the 125 High Street site. More detailed study of the potential for the separation of storm and sanitary flows should be included in the Final EIA.

1.32 The discussion regarding water supply impacts also is inadequate and does not respond to the Scope requirements. There is no discussion of the water service system serving the project site, of its adequacy, and of the project's impact on the capacity of the system to serve the project (as well as other
1.33 existing and proposed projects in the area). Mitigation measures to reduce water demand also should be described. In addition, the total water con-
1.34 sumption requirements, including cooling water, should be given in the FEIA.

6.10 Historic Landmarks

1.35 The Boston Landmarks ratings for the existing buildings on the site should be included, as required in the EIA scope (pp. 6.104, 2).

1.36 Both the Boston Landmarks Commission and the Boston Preservation Alliance (BPA) have expressed concern about the potential impact of the project on the historic Richardson Block on Pearl Street. The BPA also commented on
1.37 the historic compatibility of the pedestrian areas surrounding the site. The Final EIA should respond to both of these issues.

1.38 The technical corrections included in the Boston Landmarks letter should be incorporated into the Final report.

6.12 Construction Impacts

1.39 Air quality impacts of the demolition phase were not discussed in the air quality section of the EIA (pg. 6.12-2).

1.40 Also, this section does not discuss construction staging areas or pedestrian safety during construction, as required by the Scope. These items should be added to the Final EIA.

As you are aware, the approval of this project is contingent upon the submission of a satisfactory Final EIA for public review, as well as a commitment to mitigation measures the Authority deems necessary to minimize adverse environmental effects identified in this environmental review process.

I thank you for your cooperation and look forward to the receipt of the Final document.

Sincerely,

William D. Whitney
Deputy Director for
Development and Urban Design

JB1/I/021287/6

The Commonwealth of Massachusetts

Executive Office of Transportation and Construction

Department of Public Works

99 High Street, Boston MA 02110

January 6, 1987

Mr. William D. Whitney
Deputy Director For Development
and Urban Design
Boston Redevelopment Authority
One City Hall Square
Boston, Massachusetts 02201

2

2.01 RE: Third Harbor Tunnel/Central Artery Project
Comments on 125 High Street Project, Draft EIA

Dear Mr. Whitney:

This is in response to your letter of December 15, 1986 to Allan Hodges of Bechtel/Parsons Brinckerhoff (B/PB), our Management Consultant for the THT/CA Project. We have reviewed the Draft Environmental Impact Assessment (DEIA) dated December, 1986 for the proposed 125 High Street Project.

We were pleased to read on p.4-38 that one of the project's objectives, reflecting the BRA's goals for the site, is to "Design the project to accommodate plans to depress the Central Artery." It should then not be difficult to cooperatively find solutions to several potential conflicts between the 125 High Street project and the depressed Central artery, that we have identified. These conflicts all relate to the design, construction and future use of Purchase Street which both projects abut and which both need for major access.

Early utility relocations, construction of the slurry wall, the traffic diversion plan during construction and the completed Central Artery depression itself will significantly affect Purchase Street at different times. Currently, the one-way southbound street serves a local access function. During construction of the Artery, Purchase Street is proposed to perform the additional function of a major construction access and haul route. After construction, Purchase Street would be upgraded in function to a major surface southbound thoroughfare.

The CA/THT FEIS described a twenty-two foot width for Purchase Street, an absolute minimum for a major surface arterial. We are thus concerned to learn that the proposed street dimension, given the present footprint of the 125 High Street project, is only 14 feet. The locations of both the box tunnel section of the mainline southbound depressed Central

Artery and the portal of the exit ramp which is to reach grade at Pearl Street and the probable need to provide for up to three lanes of southbound surface traffic will require the widening of Purchase Street. Accordingly, the depressed Central Artery project may encroach on the 125 High Street site as presently proposed. MDPW staff have met with the project developers and attended the December 17, 1986 meeting of the Traffic Liaison Committee to express the CA/THT unit's concern about this conflict.

In addition, we have real concern about locating the new fire station and the only garage ingress/egress on Purchase Street. This fire station is and will continue to be extremely active throughout the day and could have a significant impact on the flow of traffic on Purchase Street. The traffic in and out of the 850 car garage in AM and PM peak hours could also create serious problems for movement on Purchase Street.

Construction planning of both projects requires early coordination to avoid conflict. Purchase Street would be reduced to one lane at Oliver Street when the excavation support wall for the box tunnel ramp section is under construction. Since the project schedule calls for opening of the southbound Artery in 1996, active construction would be underway adjacent to the 125 High Street parcel for about three years. The multi-year reduction of Purchase Street to a single lane could create some very difficult problems for the operation of both the fire station and the parking garage.

Now is the time to coordinate design requirements for both projects. We invite the Prospect Company to meet with MDPW staff and our consulting engineers to inspect our current plans and to discuss mutually acceptable accommodations. Please call Robert Snowber, agency Liaison Manager for B/PB, at 350-0049 to arrange the meeting.

We appreciate the opportunity to review the DEIA for the 125 High Street Project.

Sincerely,

Mario H. Tocci

Mario H. Tocci
DIRECTOR I-90/I-93 PROJECT

MHT:MRB:rm
cc: M. Coogan, Undersecretary/EOTC
M. Mirsky, Project Manager - B/PB
Chief Paul Cook/Boston Fire Dept.
W. David McGary/Spaulding & Slye
R. Dimino/Boston Traffic and Parking Dept.
Steve Davis/EOEA/MEPA

Boston

Raymond L. Flynn, Mayor

Jan. 12, 1987

Secretary James S. Hoyte
Executive Office of Environmental Affairs
100 Cambridge St.
Boston, MA 02210

3

ATTN: MEPA Unit

RE: 125 High St. Draft Environmental Impact Report

Dear Secretary Hoyte:

This department has reviewed the above DEIR, and would like to submit the following comments. The proposed development represents a significant addition of commercial office space in the downtown. It is important that the traffic impacts be correctly estimated, and that the project design minimizes adverse effects.

The report's assumptions regarding transit use, although ambitious, are generally reasonable and in line with other estimates made in connection with projects in the Financial District. However, the compilation of background development includes some projects, such as South Station Phase III, whose size and development schedule are not yet determined, and which in fact may not be constructed at the stated scale in 1994. These assumptions create a background scenario against which the impacts of the proposed project create a smaller percentage increase than if less development was assumed.

3.01 The most serious impacts of the project are likely to be at the intersection of Congress and Purchase Streets. Given that the level of service at this intersection is projected to be at "F" in 1994, with a volume/capacity ratio of 1.25 in the no-build scenario, the volume that this project would add represents a significant deterioration in an already unacceptable situation.

3.02 The City of Boston is concerned, both as a policy and an environmental issue, with the shortage of short-term parking spaces downtown. In reviewing the Access Plan for this project, the City will endeavor to arrange for the provision of a mix of long- and short-term on-site parking.

Richard A. Dimino, Commissioner, Traffic and Parking
City of Boston/City Hall Square/Boston, MA 02201

3.03 I am in receipt of a letter dated January 6 from Mario Tocci, director of the I-90/ I-93 project, which outlines the needs of the Central Artery depression to take land along the Purchase St. frontage of this property in order to accommodate ramp design. The proponent has been informed of this situation. If further communications between the proponent and the I-90/I-93 engineers result in a redesign of this project, it is important that the solution take account of the needs of the Fire Department for rapid egress from the station located on the project site.

Thank you for the opportunity to comment on this DEIR. We look forward to reviewing the Final EIR, and to working with the proponents toward approval of their Access Plan.

Sincerely,

for Richard A. Dimino
Commissioner

191 Hamilton Street
Cambridge, Mass. 02139
January 11, 1987

COMMENTS ON DRAFT ENVIRONMENTAL IMPACT ASSESSMENT

REPORT FOR THE 125 HIGH STREET PROJECT

To : Boston Redevelopment Authority/The Prospect Company

4

From : Stephen H. Kaiser

I have reviewed the transportation and wind sections of the report and offer the following comments :

1. The scope provides a fairly complete list of items to be covered in the EIR, but in a general way which is not clearly site-specific. For example, the project study area should be defined to include all key bottlenecks affecting traffic circulation to and from the site.
4.01

2. Site impacts should have considered congestion on the Central Artery in more detail, most notably capacity impacts on ramp merges and weaves. Earlier studies (such as Commonwealth Pier) considered the effects of the ramp merge from Northern Avenue onto the Artery. With the added new development in the area, the functioning of these ramp merges and the backups into the Atlantic/Northern Avenue intersection (whether signalized or not) presents a critical circulation issue.
4.02

3. The report projects high levels of traffic demand in excess of available capacity for both the No-Build and Build conditions in 1994. Because actual traffic volumes cannot exceed capacity, what are the actual estimated 1994 traffic FLOWS in the area, allowing for diversions to other routes, times, etc. Stated in different terms, how is the excess demand handled by the system : diversions, vacancies, ride-sharing, transit, etc.? Some delays are shown as 60+ seconds. What was the actual calculated delay? What are present measured peak hour delays at intersections in the area?
4.03

4. The year 1994 is set as the completion year for the Third Harbor Tunnel, and the report indicates that 5% of the site traffic would use this route. I understand that 1994 is the optimistic goal for the tunnel : what happens if there is a delay in completion of either the tunnel or its ramp connections at either end, so that the tunnel is not operational in 1994?
4.04

5. While the new tunnel is targeted to become operational in 1994, the Depression of the Central Artery will -- according to present plans -- be under construction in 1994. How will this construction affect the capacity of the the Central Artery (from the present Dewey Tunnel up to Marketplace Center) and the intersections within the study area of the report?
4.05

6. There has been considerable construction in the Dewey Square and Summer
4.06 Street area of the city in recent years. How do recent (1985-86) counts compare with counts several years ago, prior to construction? The MBTA construction in particular has produced significant delays in the area, with resultant reductions in volumes of traffic actually moved through the area.

7. The TRANSIT capacity measurements are a notable initiative over
4.07 earlier studies which were based entirely on theoretical calculations of loading and schedules. The 500 Boylston Street project report estimated capacity as 11,160 passengers per hour in one direction. The present report, on the basis of Fall 1986 measurements at Arlington Station, shows a capacity of only 7,500 pass/hr., yet estimated ridership is 10,000 pass./hr., again based on Fall 1986 measurements. How could the same measurements show such a difference between capacity and counted ridership? The equivalent V/C is 1.33, so there must be a 33% error in the calculation. It is likely that the Green Line capacity with a virtually 100% LRV fleet will be in the range of 150-170 pass/car, rather than the 130 average (which applied to the mixed fleet of several years ago).

Because our understanding of both the Red and Green Lines is very fragmentary, I would urge that there be a compilation of counts covering enough years to indicate what actual capacities have been achieved in past years. In 1926, prior to either PCCs or LRVs, there were 14,000 pass./hour one-way at Kenmore on the Green Line, and a 1971 count showed the Arlington count to be 10,918. The biggest drop in system ridership occurred around 1981, but by 1983 had recovered to 9,000. By November 1984, the Green Line at Arlington operated at 59 second headways, with 80 cars carrying 10,403 passengers. The current report lists peak ridership as 10,000 pass/hour.

Similarly, we need a chart of ridership trends on the Red Line. The existing figure of 7,100 Red Line riders on the Harvard Branch must reflect the severe disruptions of ongoing track and station reconstruction. The transit analysis should develop a scenario of undisturbed service for 1994 conditions.

For all lines data is needed for the average number of trains scheduled for service in the peak hour and the number of trains actually on the line. The capacity of the Red Line appears to have been increased by 50% because of the use of 6-car trains, but the system will likely be limited by the number of available cars. The Red Line capacity assessment should consider the effects of both the Alewife Extension and the added cars to the existing Red Line fleet.

Does the Orange Line have enough cars to operate 6-car trains at 4.5 minute headways?

8. Given the severe access problems of V/C saturation and parking shortages associated with the numerous Dewey Square and South Boston
4.08 development sites and the very primitive state of transit planning in the area, the Final EIR should present an exemplary analysis of transit operations and mitigation potentials.

8. The Wind results are not presented with great clarity. There should be
4.09 clear presentation of the comfort/safety criteria for wind velocities, and a priority listing of wind speeds at the various locations within the project. Each site should also include some notation regarding the likely volumes of pedestrian activity in the area. How accurate are the models? How closely can a wind tunnel model produce measured wind speeds which match similar prevailing winds for existing site conditions? Is the likely error 10%, 20% 30%?

Boston is a special location because of its generally positive and practical walking environment, yet it also suffers from high winds and a litter problem. What are the wind standards peculiar to Boston which the BRA recommends and does the project (with allowance for modeling errors) come close to meeting these standards?

9. What are the total pedestrian volumes heading towards Dewey Square?
4.10 Figs. 6.1-6 and -17 show an increase of about 2900 pedestrians between existing 1986 PM and 1994 PM Build, including all developments. Does this mean there will be an additional3,000 pedestrians going through Dewey Square in the peak hour? Did the traffic analysis take into account the large influx of pedestrians circulating in the area? If so, how?

The pedestrian levels of service appear to be based on movement along sidewalks without driveways or intersections. What is the effect of driveways and intersections on pedestrian levels of service?

10. What sort of mitigation is being proposed for traffic, parking,
4.11 pedestrians and transit?

Stephen H. Kaiser

Boston

January 6, 1987

Mr. William D. Whitney
Deputy Director for Development and Urban Design
Boston Redevelopment Authority
One City Hall Square
Boston, Mass. 02201

5

Re: 125 High Street Project

Dear Mr. Whitney:

We have reviewed the Prospect Company's Draft Environmental Assessment Report paying particular attention to areas pertaining to the fire station.

5.01 Most of the data, although appreciated, is of no direct concern to the Fire Department. However, your attention is directed to the several references to parking and in every case mention is made of 25 parking spaces for fire department personnel. As discussed with you earlier, a minimum of 30 spaces is required. The 30 is a compromise from our actual needs which approximates 40 spaces. We will insist on 30 spaces - which must be controlled by card entrance or some other security system that will assure they are always available only to Fire Department personnel and not used even temporarily by others.

5.02 Your attention is also directed to page 6.12-4 of Section 6.0 - Environmental Impact Analyses. Under 6.12.4 "Other Construction Impacts", the second sub-paragraph reads, "the new fire station will occupy portions of the first three floors". As you know, the Fire Department prefers one floor fire stations for safety reasons (eliminates sliding poles, etc.) but recognizing the value of space in downtown Boston we are amiable to two floors. We are aware the design of this station into another building is unique and involves unconventional considerations. We ask for additional discussion relative to a three story fire station.

5.03 Some of the drawings would indicate that the structure housing the fire station will overhang the required 45' apron in front of the apparatus floor. It is not clear if there are to be support columns for this overhang but we would point out that for the most part the apron should be clear of any obstructions. Support columns at the extremities of the apron would be acceptable.

January 6, 1987

Page 2 of letter to Mr. William D. Whitney
Boston Redevelopment Authority

Re: 125 High Street Project

The other comment the Fire Department has is regarding the demolition of
5.04 the present Traveler's building. Implosion is mentioned as a possible alternative. This would require close coordination with the Fire Prevention Division relative to blasting permits, bonding, etc. I am sure you are aware of this.

Thank you for including the Fire Department in each phase of the planning.

Sincerely,

BOSTON FIRE DEPARTMENT

Paul F. Cook
District Fire Chief
Planning & Logistics Division

PFC/st

CC: Commissioner Stapleton

Boston Water and Sewer Commission

10 Post Office Square
Boston, Massachusetts 02109
617-426-6046

January 9, 1987

Mr. William D. Whitney
Boston Redevelopment Authority
Boston City Hall
One City Hall Square
Boston, Massachusetts 02201

Att: MEPA Unit

6

RE: 125 High Street
Draft EIR

Dear Mr. Whitney:

The Boston Water and Sewer Commission has reviewed the Draft Environmental Impact Report submitted for the above-referenced project. The following is a summary of our comments:

1. The Report does not adequately describe the existing sewerage system bordering the site. There was no discussion of either the existing capacity or the existing usage of the system. There also is no discussion of the effects of the proposed development on the existing system.

6.01

2. The project proponent does not mention that the Boston Water and Sewer Commission has a new 15" storm drain in Oliver Street built by the proponents of International Place. The Boston Water and Sewer Commission feels that this presents the opportunity for the extension of sewer separation to the proposed site.

6.02

3. There is no discussion of the existing water system in the Report. There also is no substantial discussion of the water demand for the proposed development in the report, including makeup water for air conditioning.

6.03

4. The Boston Water and Sewer Commission is concerned about the proposed use of the implosion method of demolition for the site. Restrictions will have to be imposed to ensure no adverse affect to our utilities.

6.04

Secretary James Hoyte
January 9, 1987
Page Two

In summary, the Boston Water and Sewer Commission feels that the Draft EIR for 125 High Street does not adequately describe the existing utilities servicing the site or the potential for separation of storm drainage. The Report also does not describe at all any impacts of the proposed development on the existing utilities.

If you have any questions, please do not hesitate to call.

Very truly yours,

Charles Button

Charles Button, P.E.
Chief Engineer

CB/FD/gf
cc: M. O. Yates-Berg, Hale & Dorr

MASS (Comm of)/ MASS HISTORICAL COMM

~~[illegible]~~
NUG 2 [illegible]
Whitney

The Commonwealth of Massachusetts

Office of the Secretary of State
Michael Joseph Connolly, Secretary

Massachusetts Historical Commission
Valerie A. Talmage
Executive Director
State Historic Preservation Officer

January 5, 1987

Stephen Coyle
Boston Redevelopment Authority
One City Hall Square
Boston, MA 02201

7

RE: 125 High Street, Boston

Dear Mr. Coyle:

7.01 The staff of the Massachusetts Historical Commission have reviewed the Draft Environmental Impact Assessment for the proposed development at 125 High Street. The project is adjacent to the Custom House Historic District, which is listed on the State and National Registers of Historic Places. The project site abuts the Richardson Block which has been nominated to the National Register of Historic Places. The three properties at the corner of Purchase and Oliver Streets, which are a component of the proposed development, have been determined to be potentially eligible for nomination to the National Register by the Boston Landmarks Commission.

7.02 The Draft EIA partially lists the historic resources within the project impact area. The report states "various aspects of the project have been planned to mitigate the effects of new construction on historic resources within the project area." However, these measures were not expounded upon. Massachusetts Historical Commission has concerns about the cumulative effort of new construction on the diminishing historic resources in downtown Boston. The Draft EIA does not describe any measures which would avoid or mitigate these adverse effects.

7.03 The staff commends the proposed rehabilitation of the three buildings at 105 and 109 Purchase Street and 127-133 Oliver Street. It is recommended that the work be done in a historically sensitive manner and in conformance with the Secretary of Interior's Standards for rehabilitation.

870121-007

These comments are offered to assist in compliance with MEPA and M.G.L., Ch. 9, ss 26-27C (950 CMR 71.00).

If you have any questions, please contact Maureen Cavanaugh at this office.

Sincerely,

Valerie Talmage

Valerie A. Talmage
Executive Director
State Historic Preservation Officer
Massachusetts Historical Commission

cc: Boston Landmarks Commission
Boston Preservation Alliance
MEPA

VAT/MC/dr

Boston
Landmarks
Commission

City of Boston
The Environment
Department

Boston City Hall/Room 805
Boston, Massachusetts 02201
617 725-3850

December 19, 1986

William Whitney
Boston Redevelopment Authority
City Hall
Boston, MA 02201

8

Dear Bill:

Our staff has reviewed the Draft Environmental Impact Assessment f
125 High Street.

There are a few technical corrections for Section 6.10 that shou
be included in the final report and are listed below.
All the material is included in the 1980 draft summary of findin
of the BLC's Central Business District Preservation Study.

8.01 Two principal examinations are not included. First, the report do
not include any archaeological assessment whatsoever and should
8.02 so. Second, in omitting the Richardson Block (properies nominat
to the National Register) from the properties in the environs
the project, obviously no assessment of the impact of the tower
these largely marble fronted mercantile buildings is included.

The beneficial impacts on the three remaining properties of t
Oliver/Purchase district are numerous. Retaining and rehabilitati
these increasingly rare late 19th c. structures is a central featu
of the project. The massing, scale, and design of the ne
components and the overall relationship to these smaller structur
does not overwhelm them or give them a sense of inferiority. Two o
the structures have been poorly modernized in the past, and the
conditions will be reversed.

Sincerely,

Judith B. McDonough
Executive Director
Boston Landmarks Commission
Environment Department

cc: MHC

8.03 The following properties should be added to Section 6.10.2 and its map.

The Richardson Block, 113-151 Pearl St., has been nominated to the National Register; as some owners have objected, it is undergoing technical scrutiny and revision for eligibility consideration.

Russia Wharf Buildings, Congress St. listed in the National Register.

The Telephone Co. Building, 185 Franklin St.

State Street Bank Building, 75 Federal St.,

These structures are within the project impact area (based on the map at 6.10-4) and are all indentified by the BLC as structures that potentially meet NR criteria in the Draft Summary of Findings of 1980.

On p. 6.10-3 the Old Federal Reserve Bank is a Boston Landmark, as is the U.S. Custom House, p. 6.10-5.

BOSTON PRESERVATION ALLIANCE

January 5, 1987

Mr. William D. Whitney
Deputy Director for
Development & Urban Design
Boston Redevelopment Authority
City Hall
Boston, MA 02201

9

Dear Mr. Whitney:

The Boston Preservation Alliance has had the opportunity to review the Draft Environmental Assessment Report for the 125 High Street Project.

The Alliance fully supports the retention of the three Post Fire of 1872 buildings on the site.

9.01 The Alliance does, however, have concerns about the affects of the proposed new construction on the historic Richardson Block located on Pearl Street. This row of buildings is on the National Register of Historic Places and is rated a category #3 in the Boston Landmark Commission's Central Business District Survey. The Proposal as presented calls for a minimal set-back on Pearl Street. The Alliance recommends a 50' cornice height on the new construction with a minimum set-back of 30' from the facade on Pearl Street. This greater set-back would alleviate the negative impacts, both visually and physically, created by a new tower on this historically significant Richardson structures.

9.02 The pedestrian area surrounding the site should also be consistent and historically compatible. We would suggest acorn lighting. In addition, the sidewalks in this area were predominantly granite and, if possible, should be replaced with the same.

The Alliance is continuing its discussions with the developer on these issues. Please keep us apprised of any changes.

Sincerely,

Antonia M. Pollak
Executive Director

AMP:ks

Old City Hall, 45 School Street Boston Massachusetts 02108 Telephone 617 367-2458

BY:SPAULDING & SLYE

Sam Sheoman

BOSTON PRESERVATION ALLIANCE

February 5, 1987

Mr. David McGarry
Project Manager
Spaulding & Slye
150 Cambridge Parkway
Cambridge, MA 02140

10

RE: 125 High Street Proposal

Dear Dave:

Thank you for presenting your current proposal for the 125 High Street project to the Executive Committee of the Boston Preservation Alliance on Monday, February 2nd.

As we discussed, the Alliance strongly supports the retention and restoration of the three historic buildings located on the site.

The question was also raised about an archeological
10.1 evaluation of the site. Has a plan been devised or a survey conducted to assess possible archeological data retrieval?

Although we continue to have concerns about the negative impacts of the project on the historic 19th century
10.2 Richardson Block, we understand the project's programmatic and site contraints.

We look forward to further discussion about the project's final articulation and materials. Please keep us informed about your progress.

Sincerely,

Susan Park

Susan Park
Chairman

cc: Valerie Talmage, MHC
Homer Russell, BRA
William Whitney, BRA
Judith McDonough, BLC
Pamela McDermott, Northeast Mgt.

Old City Hall, 45 School Street, Boston, Massachusetts 02108 Telephone 617 367-2458

8.2 COMMENT AND RESPONSE CROSS-REFERENCING INDEX

All comments which have been received during the public review periods for the DEIA have been responded to in this FEIA. Since the report has been reproduced in full, responses to many of the comments are incorporated into the text. In the following tables, each comment has been summarized and numbered to correspond with the comments as they appear in Section 8.1. Following each comment summary, the location of the response is indicated.

Generally, the index acts as a guide to two potential locations. It cites the location of the response in the FEIA or it directs the reader to Section 8.3. In Section 8.3, those comments that are not responded to within the text of the FEIA are addressed.

COMMENTS ON DEIA

		Section
1. BOSTON REDEVELOPMENT AUTHORITY (BRA)		
1.01	Traffic volumes for One Twenty Five High Street and 125 Summer Street common intersections are significantly different - explain.	8.3
1.02	The FEIA should discuss a commitment to implement roadway conditions to improve already unacceptable conditions in the project area, notably the Congress and Purchase Street intersection.	8.3
1.03	There are a number of potential conflicts between the I90/I93 project and One Twenty Five High Street. The FEIA should describe how the issues are being addressed.	6.1.3.8
1.04	The FEIA should evaluate the impact of garage traffic (entering and exiting) on intersections, both during the AM and PM peak hours.	8.3
1.05	Accessibility to and from the fire station should be examined in the FEIA.	6.1.3.13
1.06	Does the new methodology used account for delays resulting from pedestrian traffic or conflicts at the intersections analyzed?	8.3
1.07	Expand on the Central Artery Impact discussion.	6.1.3.7
1.08	The discussion of the Dewey Square TSM Alternative B should indicate the effect of LOS levels with implementation of this alternative.	6.1.3.8, 8.3
1.09	In Table 6.1-27, should not the "15" under B be "215"?	6.1.4.1
1.10	Discrepancy of Fan Pier/Pier 4 FEIR and Fan Pier/Pier 4 numbers should be resolved in the FEIA. Also, the FEIA should evaluate the effect of the use of different analysis techniques on the accuracy of future predictions.	6.1.4.3

		Section
1.11	The difference in transit numbers in the 125 Summer Street EIR should be explained.	8.3
1.12	The rapid transit impact discussion should include an analysis of the impact on the Red Line at South Station.	6.1.3.9
1.13	Further justification of the 30%/70% auto/transit mode split is required.	6.1.3.1, 8.3
1.14	A resolution of the parking spaces for the Boston Fire Department should be included in the FEIA.	6.1.3.11
1.15	The City of Boston has expressed concern that a mix of both short/long-term on-site parking spaces be provided.	6.1.3.11
1.16	Include the pedestrian LOS analysis.	Appendix A
1.17	In the FEIA, summarize the methodology used to determine the pedestrian LOS. Does the methodology include the effects of driveways and street intersections?	6.1.3.10, 8.3
1.18	Include in the FEIA any change in wind impact due to the redesign of the office building.	6.2.3, 8.3
1.19	Describe the wind standards used by the BRA to evaluate the acceptability of pedestrian level winds in the project vicinity. Include an analysis as to whether the project meets these standards and the impact on various activities.	6.2.3.4, 8.3
1.20	Was a design change made as a result of the erosion study? Was it analyzed in the hot wire study?	8.3
1.21	What is the explanation for the difference in wind studies for International Place and One Twenty Five High Street?	6.2.3.3, 6.2.2.4, 8.3
1.22	Explain why the One Twenty Five High Street study indicates winter wind speeds close to annual speeds.	8.3

		Section
1.23	The FEIA should propose methods to mitigate wind violations.	8.3
1.24	Label last two columns on Table 6.2-3.	Table 6.2-3, 8.3
1.25	Better quality photographs required in Appendix B-1 for the FEIA.	Appendix B, 8.3
1.26	The winter description of noontime and mid-afternoon shadow effects is reversed.	6.3
1.27	The project does affect the Customs House District (shadow). Note the spring/fall impact on Post Office Square Park.	6.3
1.28	Further mitigation measures are needed as the air quality analysis indicates a potential violation of National and State standards at the Congress and Purchase Street intersection.	6.6.6, 8.3
1.29	An apparent discrepancy between Table A-5 and Worksheet 1 should be explained.	8.3
1.30	The FEIA should discuss the existing utility system, its adequacy to handle project loads and project impact.	6.8.2, 6.8.3, 6.8.4, 6.8.5
1.31	More detail on the separation of storm and sanitary flows is required for the FEIA. Include the possibility of a tie-in with the new 15" storm drain on Oliver Street.	6.8.2
1.32	Include a discussion of the water system serving the site, the adequacy of this system to serve the project, and project impacts.	6.8.7
1.33	Mitigation measures to reduce water demand should be included in the FEIA.	6.8.6
1.34	Total water consumption requirements, including cooling water is required for the FEIA.	6.8.7
1.35	Include the Boston Landmark's ratings for the existing buildings on the site.	6.10.1

		Section
1.36	Discuss potential impact of the project on the historical Richardson Block.	6.10.3
1.37	Comment on the historic compatibility of pedestrian areas surrounding the site.	6.10.3
1.38	The technical corrections included in the Boston Landmark's letter should be incorporated into the FEIA.	6.10.2
1.39	The air quality section should include a discussion on impacts to air quality during the demolition phase.	8.3, 6.6.8
1.40	Construction staging areas and a discussion on pedestrian safety during construction should be included in the Final EIA.	6.1.4.2

2. MA EXECUTIVE OFFICE OF TRANSPORTATION AND CONSTRUCTION (EOTC)

2.01	Third Harbor Tunnel/Central Artery Project. Potential conflicts relating to the design, construction, and future use of Purchase Street.	6.1.3.8

3. RICHARD A. DIMINO, COMMISSIONER, BOSTON TRAFFIC AND PARKING

3.01	Discuss the volume of traffic this project will add to an already unacceptable situation.	8.3
3.02	There is concern with the shortage of short-term spaces downtown. Discuss the provisions of a mix of long- and short-term on-site parking.	6.1.3.11
3.03	If redesign of the project takes place, the needs of the Fire Department for rapid egress from the station located on the project site need to be examined.	6.1.3.13

		Section
4. STEPHEN H. KAISER		
4.01	The project study area should be defined to include all key bottlenecks affecting traffic circulation to and from the site.	8.3
4.02	Consider congestion on the Central Artery in more detail.	6.1.3.7
4.03	With high levels of traffic, how will the excess demand be handled by the system? What is the calculated delay? What is the present peak hour delay?	6.1.3.7, 8.3
4.04	The report indicates use of the Third Harbor Tunnel. What happens if there is a delay in completion of the tunnel?	8.3
4.05	How will the construction of the project affect the capacity of the depression of the Central Artery and intersections within the study area?	8.3
4.06	Considerable construction in recent years has resulted in significant traffic delays and reduction of volume of traffic moved through the area. How do recent traffic counts compare with counts taken several years ago?	6.1.2.2
4.07	Better transit capacity measurements are encouraged.	6.1.2.4, 6.1.3.9, 8.3
4.08	The FEIR should present an exemplary analysis of transit operations and mitigation potentials.	6.1.2.4, 6.1.3.9, 8.3
4.09	A presentation of the comfort/safety criteria for wind velocities and a priority listing of wind speeds at various locations within the project is suggested. What are the likely volumes of pedestrian activity in the area? What is the likely error of the wind tunnel model? Does the project come close to meeting BRA wind standards?	8.3

		Section
4.10	What are the total pedestrian volumes heading towards Dewey Square? Did the traffic analysis take into account the large influx of pedestrians? What is the effect of driveways and intersections on pedestrian levels of service?	6.1.3.10, 8.3
4.11	What mitigation measures are proposed for traffic, parking, pedestrians, and transit?	6.1.4, 8.3

5. BOSTON FIRE DEPARTMENT

5.01	Discuss the allotment of 30 parking spaces for fire department personnel and security system to assure available parking.	8.3
5.02	Additional discussion is required relative to a three-story fire station.	8.3
5.03	In regards to support columns for the overhang, the apron in front of the apparatus floor for the fire department should be clear of any obstructions.	8.3
5.04	Coordination of the implosion method with the fire department is suggested should this method be chosen by the developer.	8.3

6. BOSTON WATER AND SEWER COMMISSION (BWSC)

6.01	Additional discussion is required to describe the existing sewer system, its capacity, and usage. Expand on the impacts of the project on the existing system.	6.8.2, 6.8.3, 6.8.4, 6.8.5
6.02	The new 15" storm drain on Oliver Street may present the opportunity for the extension of sewer separation to the proposed site.	6.8.2
6.03	Include a discussion of the existing water system and the water demand of the project, including makeup water for air conditioning.	6.8.7

		Section
6.04	Should the implosion method of demolition be chosen by the developer, restrictions would be imposed to ensure protection of the utilities.	8.3

7. MASSACHUSETTS HISTORICAL COMMISSION

7.01	The project site abuts the Richardson Block which has been nominated to the National Register of Historic Places.	6.10.2
7.02	The Commission has concerns about the cumulative effort of new construction on the historic resources in downtown Boston. Describe any mitigative measures to avoid these effects.	8.3
7.03	It is recommended that rehabilitation on the three buildings of historic value be done in conformance with the Secretary of Interiors' Standards for rehabilitation.	8.3

8. BOSTON LANDMARKS COMMISSION

8.01	Include an archaeological assessment of the site.	6.10.1
8.02	Include any impact of the tower on the buildings of Richardson Block.	6.10.3

9. BOSTON PRESERVATION ALLIANCE

9.01	Address concerns about the affects of the proposed new construction on the historic Richardson Block located on Pearl Street.	6.10.3
9.02	Note suggestions at keeping the area surrounding the site historically compatible.	6.10.3

		Section

10. BOSTON PRESERVATION ALLIANCE

10.01	Has the site had an archaeological evaluation?	6.10.1
10.02	Address concerns about the negative impact on Richardson Block.	6.10.3

8.3 MISCELLANEOUS RESPONSES TO COMMENTS

As noted earlier, most of the comments were responded to in the main text of the appropriate sections and are identified by the cross-reference index. The following are miscellaneous comments that are not necessarily reflected in other sections.

1.01

The One Twenty Five High Street DEIA was prepared after the submittal of the DEIA for 125 Summer Street to the BRA and the issuance of comments by the BRA. In response to those comments, the networks for both projects were reviewed and revised to make them consistent. The DEIA for One Twenty Five High Street contains these revised networks. When the FEIA for 125 Summer Street is submitted, the existing networks presented in the report will be consistent with those presented in the DEIA for One Twenty Five High Street.

1.02

As stated in the DEIA, the proponent has committed to work with the City to support the implementation of the proposed roadway improvements. However, if these measures are to have a positive effect on projected traffic conditions, the City itself must take the initiative to carry out these suggested improvements. For instance, the recommended parking restriction on the southbound approach of Purchase Street at the Congress Street/ Purchase Street intersection must be instituted by the City and strict enforcement of this measure must be provided by the City. Any loss of curbside parking would be offset by the provision of the 150 commercial spaces within the project's garage. This approach, requiring close coordination between the proponent and the City, should be followed when implementing any or all of the suggested roadway improvements.

1.04

This comment points out a posting error on the 1994 AM peak hour No-Build and Build networks. The southwestbound through volumes on Purchase Street at the Purchase Street/Relocated Central Artery Ramp/Oliver Street intersection should be 335 and 806 vehicles, respectively, under the No-Build and Build conditions, not 385 and 856 vehicles. Based on the corrected network numbers, 613 vehicles will be entering the One Twenty Five High Street garage. This figure is consistent with the total inbound AM peak hour vehicle trips generated by the project, as found in Table 6.1-9.

The 613 vehicles which are projected to arrive at One Twenty Five High Street during the AM peak hour can be viewed as a conservative projection (i.e., on the high side). As noted in the parking section of the report, the demand for parking exceeds the available supply. Due to this fact, a percentage of the 613 vehicles generated by the site in the morning peak hour are expected to either change travel mode or rideshare. Therefore, it can be considered to be the worst case scenario that a total of 613 vehicles would enter the One Twenty Five High Street garage during the AM peak hour.

Lane capacity, with an automatic ticket dispenser and gate control, is generally estimated to be 350 vehicles per hour when tight turning movements are required, as in One Twenty Five High Street garage. With two lanes available for arriving vehicles in the morning peak hour, a total of approximately 700 entering vehicles per hour can be accommodated by the project's garage. Less than 90 percent of the total capacity of the two entry lanes would be required to process the worst case figure of 613 vehicles. Also, there is sufficient space within the confines of the building for 23 vehicles to wait before passing through the garage entrance gates, a feature not commonly found in many Downtown buildings. Since the garage can allow the rapid entry of arriving vehicles and has sufficient queuing area to handle

any surges in arrival rates, trafic is not expected to back out onto Purchase Street or to have any adverse effects on the level of service of the intersection of Purchase and Oliver Streets in the AM peak hour.

In the PM peak hour, gaps in Purchase Street traffic will control egress from the One Twenty Five High Street garage and any queuing of exiting vehicles will be found within the garage itself. Due to this and the fact that Purchase Street is one-way away from the Purchase Street/Oliver Street intersection, exiting traffic from the garage is not expected to have any negative effect on either Purchase Street or its intersection with Oliver Street in the evening peak hour.

1.06

The new methodology from Special Report 209 utilized in the intersection level of service calculations takes into account the effects that pedestrians have on intersection operations in two ways. First, at intersections where pedestrian actuation or a pedestrian cycle is provided, green time over cycle length (g/c) ratios are reduced to reflect the delays experienced by intersection traffic while pedestrians are allowed to cross. Second, the methodology takes into account the delays encountered by right turning vehicles due to pedestrian crosswalk movements and incorporates these effects in the intersection capacity and level of service calculations.

1.08

The discussion of the Dewey Square TSM Alternative B presented in Section 6.1.3.8 has been expanded in order to include the effects that the implementation of these proposed roadway improvements are projected to have on the level of service of intersections located within the One Twenty Five High Street study area.

1.11

As described earlier in the response to comment 1.01, the DEIA for One Twenty Five High Street was prepared after comments were issued by the BRA on the 125 Summer Street DEIA. In response to those comments, the transit data for both projects were updated. This updated information was presented in the DEIA for One Twenty Five High Street and will be reflected in the FEIA for 125 Summer Street when it is submitted to the BRA.

1.13

The discussion concerning the 30 percent/70 percent auto/transit mode split under the trip generation section in the report has been expanded in order to further justify the use of these values. Also, the letter from New England Telephone addressed to Jung/Brannen found in Appendix A of the DEIA has been removed. This is due to the fact that the survey data summarized in this letter was preliminary and has been superseded by the data found in the tables which followed the letter entitled "Real Estate Operations Survey". These tables, which represent the final results of the survey, still appear in Appendix A and are referred to in the text.

1.17

The discussion within the pedestrian analysis section of the report has been expanded in order to briefly summarize the methodology used to determine pedestrian level of service on the proposed sidewalks surrounding the site. It should be noted at this point that the procedure utilized does include the effects that driveways and street intersections have on pedestrians. When driveways are found at a particular analysis location, effective sidewalk width values are adjusted appropriately to reflect narrower effective sidewalk widths. If a study location is situated near a busy driveway or street intersection, the

effects that vehicular volumes or traffic signals have on pedestrians are reflected in the greater variations in volumes over short periods of time. Larger pedestrian volumes per time period utilizing the same effective sidewalk width cause pedestrian flow rates to increase, resulting in drops in level of service. In this study, the mid-block locations analyzed are not actually influenced by either the fire station and garage drives or the street intersections surrounding the site.

1.18

A supplemental hot-wire investigation has been carried out since the DEIA submission in order to address the effects of alterations in the project since the original submission. This investigation is detailed in Section 6.2.3 and suggests that the design changes are generally advantageous for the pedestrian level wind environment. No locations exceed the BRA guideline of 31 mph peak gust 1% of the time.

1.19

Guidelines that can be used to judge the acceptability of the pedestrian level winds are included in both the original study and in the supplement. The latter includes guidelines as suggested originally by both Melbourne and Davenport. The supplemental report compares the data for this study with those guidelines in detail (see Section 6.2.3.4).

1.20

Although the erosion study did indicate that sealing some of the openings in the arcade at the corner of Pearl and High Streets would be effective in reducing wind speeds through the arcade, subsequent hot-wire measurements found that these locations were not excessively windy in their original state and hence, design changes were not incorporated in the hot-wire study.

1.21

The comparison between the data taken in the International Place study and the One Twenty Five High Street study was discussed in detail in the original report in Sections 6.2.2.3 and 6.2.2.4.

That discussion suggests that the data can be divided into three groups: those locations very close to International Place, which show good agreement; those in built-up city areas but away from International Place, which show reasonable agreement; and those in open areas away from the built-up city and International Place, which show poor agreement. This classification suggests best agreement when the locations are directly in the aerodynamic influence of major structures. It also suggests that there may have been differences in the way that the approaching flow was modeled. In fact, this was investigated, although not reported in detail, as part of the supplemental study investigation. Altering the approaching flows, within reasonable bounds, introduced changes no larger than about 30 to the aerodynamic coefficients and less than 10% to the final predictions.

Other differences may have existed of which we are unaware -- such as details of modeling, detailed location of probes, etc. Finally, the International Place study was modeled at large scale. It is possible that the larger model size and associated increased blockage within the wind tunnel could also increase surface wind speeds in exposed areas.

Notwithstanding the above comments, there appears to be no rationale for the differences seen for westerly winds for location 2, which we would suggest is most likely spurious data. Such events do occur, and, in fact, the data in our original tests for probe 13 in the 30-story building only configuration is also believed to be spurious.

1.22

The wind climate model used in these studies was based on surface data at Logan Airport. This model predicts the following comparative wind speeds normalized to annual levels.

	Once Per Year Speed	Once Per Ten Year Speed
Annual	1.0	1.0
Spring (March-May)	1.01	1.02
Summer (June-August)	0.84	0.86
Autumn (September-November)	0.94	0.95
Winter (December-February)	1.02	1.00

These indeed show winter winds to be a little faster than annual on average. In our report, however, the wind speeds are predicted for each location, accounting for the different aerodynamic sensitivity of each. These individual results show scattered seasonal effects, but on average, the net shielding of the site by the surrounding city for northerly and westerly directions, in particular, introduces a net bias to the overall seasonal averages.

1.23

No mitigation methods are proposed because the wind conditions in the revised project as presented in the supplemental data meet the Boston environmental wind criteria.

1.24

This change has been made.

1.25

Original photos are being supplied to the BRA with the FEIA. Furthermore, a key diagram to assist in interpreting the photos has been added at the beginning of the collection.

1.28

The air quality design goals of One Twenty Five High Street are: a) to not adversely effect existing air quality and b) where CO "hot spots" are noted to provide measures to mitigate any incremental increases associated with the project. At all but the Purchase Street/Congress Street intersection (prior to mitigation), the project will not adversely effect air quality as the NAAQS for CO will be maintained (see Table 6.1-3). Incremental CO increases at all receptors studied are small, especially eight-hour levels which are generally the most restrictive. At the intersection of Purchase and Congress Streets, the project prior to mitigation demonstrated only a minimal increase to a marginal violation (Receptor 3A). A detailed discussion of project impacts is presented in Section 6.6.5 of the FEIR, while Section 6.6.6 provides a discussion of mitigation measures. The analysis of mitigating measures demonstrated that improvements (planned by the City of Boston) relative to signal timing at the Purchase/ Congress Street intersection, would reduce conflicts at the Congress Street eastbound approach, thereby eliminating violations of the eight-hour NAAQS for CO. In addition, the significant commitments toward traffic mitigation encompassed in the Access Plan submitted to the City of Boston, should also mitigate air quality impacts.

1.29

The apparent discrepancy of the peak 1-hour vehicular approach speeds at the intersection of Purchase and Congress Streets in Table A-5 (Table C-5 in the FEIA) and Worksheet 1 is a result of an incorrect entry to Worksheet 1. This data summary sheet should show a peak 1-hour speed of 20 mph. The actual air quality analysis, however, correctly used emission rates based on a 20 mph approach speed. This discrepancy was corrected on Worksheet 1 in Appendix A (Appendix C in the FEIA).

1.39

The project's construction related air quality impacts discussed in Section 6.6 include the approximate six month demolition phase. Since no known data was available on emissions of fugitive dust during the demolition phase itself, the assumption was made that emissions were similar to those classified under general heavy construction activities. The text, section 6.6.8, has been revised to explicitly reflect this.

3.01

See response to comment 1.02.

4.01

A total of 17 intersections has been included in the traffic study area. These locations include all major routes to and from the Central Artery and all locations which would receive a significant share of project trips. Any locations which would be substantially impacted by project-related trips have been included in the analysis.

Actual hourly traffic flows at the study intersections which are currently at or near capacity cannot be expected to increase substantially under future conditions. The expected increase in demand, as shown in the No-Build and Build networks, will need to be accommodated by a number of options available within the transportation system. Some vehicles may simply continue to travel through the affected intersections and cope with the increased delay. Other drivers may decide to utilize any excess capacity at these locations which may be available in the shoulder hours (the hours on either side of the peak hour). Still, others may shift to alternative routes, completely avoiding the intersections operating over capacity, although this option is of limited use in the congested Downtown area.

Demand-reduction measures provide a major opportunity to eliminate excess demand. Ridesharing, in the form of carpools and vanpools, is one way to decrease projected demand by reducing the number of vehicles using the roadways, and thus lessening congestion. Also, the increased use of public transportation -- commuter buses, commuter rail, and rapid transit -- is an excellent alternative to help alleviate excess traffic demand. Both demand-reduction approaches can be expected to be particularly effective because of the concentration of other commuters in the area with whom a ride can be shared and the concentration of extensive mass transit services.

In response to the comment concerning delays exceeding 60 seconds, actual delays in excess of 60 seconds are not calculated with the methodology from the 1985 Highway Capacity Manual (HCM). The HCM states that the equation used to obtain the volume-to-capacity ration (V/C or X) for a particular lane group "yields reasonable results for values of X between 0.0 and 60.0 seconds. Where over-saturation occurs for long periods (greater than 15 minutes), it is difficult to accurately estimate delay, because spillbacks may extend to adjacent intersections. The equation may be used with caution for values

of X up to 1.2 minutes, but delay estimates for higher values are not recommended." Due to this fact, the computerized version of the HCM methodology used for this analysis is not capable of calculating delays in excess of 1.2 minutes and reports delays in excess of 60 seconds as 60+.

The existing peak hour delays at the intersections examined in the report were not measured in the field but were calculated in the level of service analyses utilizing thephysical characeristics and volume data collected at each study location. The weighted average intersection delay for each signalized location under existing conditions within the study area appears in Tables 6.1-18 and 6.1-19 for the AM and PM peak periods, respectively.

4.04

In order to assess the resulting impact on traffic operations within the One Twenty Five High Street study area in the Third Harbor Tunnel (THT) is not operational in 1994, the 5 percent of background development and project volumes projected to utilize the THT were redistributed to the Callahan and Sumner Tunnels. After redistributing both background and project traffic, level of service analysis for Build conditions was performed on the intersections which were significantly affected by this shift in volumes. Seven of the 17 study intersections are significantly impacted by the shift in the AM peak hour and four are impacted in the PM peak hour.

Table 8.3-1 compares the level of service at the impacted locations for the 1994 Build conditions with and without the THT in the roadway network. In the morning peak hour, the intersection of Congress Street/Purchase Street experiences a drop in level of service from LOS C" to LOS "F". Although not as severely impacted, the unsignalized intersection of Oliver Street/Purchase Street/Relocated High Street Ramp shows decline in reserve capacity. The five other intersections impacted in the AM peak hour will experience either moderate improvements in V/C ratios or no change.

TABLE 8.3-1
LEVEL OF SERVICE COMPARISON OF 1994 BUILD VOLUMES
WITH AND WITHOUT THE THIRD HARBOR TUNNEL

	1994 Build Analysis With Third Harbor Tunnel						1994 Build Analysis Without Third Harbor Tunnel					
	AM Peak Hour			PM Peak Hour			AM Peak Hour			PM Peak Hour		
Intersection	V/C*	Delay**	LOS***	V/C	Delay	LOS	V/C	Delay	LOS	V/C	Delay	LOS
Summer/Atlantic	0.87	23.8	C	1.03	60+	F	0.79	21.2	C	No Change		
Congress/Purchase	0.98	18.9	C	1.38	60+	F	1.10	60+	F	1.42	60+	F
Congress/Atlantic	1.40	60+	F	1.28	60+	F	1.41	60+	F	1.40	60+	F
Atlantic/Northern	1.65	60+	F	1.44	60+	F	1.52	60+	F	1.48	60+	F
Broad/Surface	0.63	19.1	C	0.57	15.8	C	0.64	21.8	C	No Change		
Surface/High/Atlantic	1.81	60+	F	1.24	60+	F	1.78	60+	F	No Change		
Oliver/Ramps/ Purchase^	236		C	395		B	214		C	378		B

* V/C = Volume-to-capacity ratio.
** Delay = Average intersection delay in seconds.
*** LOS = Level of Service.
^ Intersection unsignalized. Analysis presents reserve capacity in vehicles per hour for the most critical movement.

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Three of the four intersections affected by the redistributed volumes in the PM peak hour show a minor increase in V/C ratio and a minor decrease in reserve capacity. The most adversely affected location is the Congress Street/Atlantic Avenue intersection where the V/C ratio increases from 1.28 to 1.40 in the evening peak hour.

4.05

The Final Environmental Impact Statement for the Third Harbor Tunnel/Central Artery project establishes criteria for construction mitigation, which include the maintenance of the current capacity of six travel lanes on the Central Artery (three in each direction) throughout the period of construction. In the vicinity of One Twenty Five High Street, this will be accomplished by virtue of the construction of a separate northbound artery tunnel along the Fort Point Channel. The early opening of this northbound tunnel will allow for connection of the new depressed southbound lanes to the existing Dewey Square Tunnel in stages so that southbound Artery capacity can be maintained.

According to the Centeral Artery Team, design development for the portion of the Artery in the vicinity of One Twenty Five High Street has not been completed. A detailed construction phasing and management plan cannot be finalized until the design development is completed. Such a plan would provide projections of the timing and extent of lane restrictions on local roadways and intersections. In the absence of a construction management plan, no projection of construction impacts on local roadways in 1994 can be made at this time.

The development team for One Twenty Five High Street has been in contact with the Central Artery team to coordinate design of the project with the Central Artery design. This coordination has provided information to the Central Artery team that will assist them in developing a construction management plan and mitigation measures when the Central Artery design work is completed.

4.07

In response to MBTA comments on previous EIRs, transit line capacities are based on the more conservative "planning" capacities of transit vehicles. As explained Section 6.1.2.4, this methodology leads to V/C ratios exceeding 1.0 in some cases.

Ridership counts dating from 1926 are not useful for a 1994 ridership forecast, because land use patterns and transit operating conditions have changed greatly. Consideration of existing conditions, projected land use changes, and programmed transit improvements provide the appropriate basis for assuming future transit operating conditions.

The Red Line/North ridership estimate of 7,140 derived from fall 1986 observations by Vanasse Hangen Brustlin is consistent with MBTA estimates. It is possible that PM peak hour ridership is somewhat suppressed by the disruptions associated with ongoing track and station reconstruction projects. If so, 1994 Build and No-Build ridership would be somewhat higher than forecast in the FEIR. However, since Red Line/North ridership is substantially less than Red Line/South ridership, the effect of this factor on the capacity analysis is not significant.

It is acknowledged that equipment availablity is a key factor in delivery of transit capacity; extended platforms do not themselves assure a 50 percent capacity increase on the Red Line. However, the MBTA has announced plans to operate six-car trains at currently scheduled frequencies. To be conservative, the 1994 capacity analysis does not assume that currently scheduled frequencies will actually be delivered. Rather, the 1994 analysis assumes that only the currently observed frequencies will be delivered. Thus, equipment shortages and reliability problems are built into the forecase, making it a real-world analysis.

As noted in Section 6.1.3.9, the Orange Line fleet is more than adequate to meet the planned schedule.

4.08

The transit analyis presented in Section 6.1.2.4 has been expanded to include a clarification of the "planning capacity" concept, an analysis of the Red Line segment between South Station and Park Street, and a calculation of frequency and fleet-size requirements on the Orange Line in 1994.

4.09

Comfort/safety criteria were included in the original report in terms of Davenport's criteria. In the supplement, this has been extended to include Melbourne's criteria as well.

The term "priority listing" is not understood.

The likely volumes of pedestrian traffic are presented in other parts of the EIA.

The likely error of the wind tunnel model is difficult to assess as a single number. Comparison with full-scale results indicate better agreement between model and full-scale as wind speeds become higher, and also as the aerodynamics become better organized (see also 1.21). "Errors" can also be viewed as either systematic, which can lead to biases, or random. It is likely that the bias errors due to problems in all aspects of the methodology are of the order of 5% to 10%. There are several reasons why one might believe the wind tunnel tends to over-estimate, particularly because of simplifications in the modeling of the surface roughness. For example, in Boston, wind tunnel tests rarely include cars and surface signs, all of which should act to decrease real wind speeds. The particular climate statistics chosen, and the model scale can also add biases.

Random errors can be introduced by omission of model detail and the exact locations of measurements. Such random errors are likely also of the order of $\pm$ 10% if predictions originating from a single probe reading are taken as representative of a

significantly larger region. Nonetheless, on average, these random errors should not contribute to the character of the windiness indicated by the measurements around a project site.

The project does meet BRA wind standards.

4.10

The pedestrian volumes for the 1994 Build condition in the AM and PM peak hours, shown respectively in Figures 6.1-16 and 6.1-17, illustrate the total pedestrian volume during each peak period at specific locations adjacent to the One Twenty Five High Street site. Due to this fact, pedestrians who pass through more than one count location have been double counted. Therefore, it is incorrect to assume that the difference between the projected 1994 Build condition pedestrian volumes and the currently existing condition pedestrian volumes counted at the southern corner of the site are the total number of additional pedestrian volume headed towards Dewey Square.

The actual additional number of pedestrians projected to head towards the Dewey Square area in the PM peak period under the 1994 Build conditions is approximately 1,550. These additional pedestrians are generated mainly by the proposed One Twenty Five High Street development and International Place, which is currently under construction and is partially occupied. The impact of these pedestrians at Dewey Square, under the 1994 Build condition, is difficult to measure. The MBTA is presently constructing a new pedestrian portal on the northern corner of Dewey Square in order for pedestrians to gain easier and improved access to the Red Line at South Station. Currently, it is not known how many pedestrians will utilize this access point to South Station. Nevertheless, the traffic analysis did take into account the effects of existing pedestrian volumes at Dewey Square crossings. For a detailed explanation of how the level of service analysis technique considers conflicting pedestrian volumes, see Section 6.1.3.10 and the response to comment 1.17.

4.11

Mitigation measures which have been proposed to help lessen the impacts on parking, pedestrians, public transportation, and traffic due to One Twenty Five High Street are presented in the "Access Plan" portion of the report (Section 6.1.4).

5.04 and 6.04

The BWSC and the Boston Fire Department expressed concern over the implosion method of demolishing the existing Travelers Building. At this writing, both implosion and the conventional method (ball and crane) are being considered. In either event, all precautionary steps and restrictions will be undertaken to ensure against effects to utility systems in the area.

7.02

In order to maintain Boston's historical context, the new construction at One Twenty Five High Street will include the restoration of three post-1880 brick buildings formerly used for commercial and manufacturing purposes which currently occupy the site. These buildings will be incorporated into the final design.

Extensive studies covered in this Environmental Impact Assessment include historical impacts. The project has been designed so that the construction and operation of One Twenty Five High Street will not detract from the historical properties in the surrounding area. In fact, the retention and restoration of the on-site historic properties emphasizes the proponent's commitment to mitigate any impact on the historic resources in downtown Boston.

7.03

Any rehabilitation of the three historic buildings on-site will be done in a historically sensitive manner.

APPENDICES

APPENDIX A

6.1.5 APPENDIX A

Summary of 1994 Background Development Vehicle-Trip Generation

New England Telephone (NET) Real Estate Operations Survey

Pedestrian Level of Service Analysis

Study Intersection Turning Movement Counts

Study Intersection Level of Service Analysis

SUMMARY OF 1994 BACKGROUND DEVELOPMENT
VEHICLE-TRIP GENERATION

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1994 BACKGROUND DEVELOPMENT
VEHICLE-TRIP GENERATION

Project	Daily Traffic	AM Peak Hour In	AM Peak Hour Out	PM Peak Hour In	PM Peak Hour Out
South Boston					
1. Commonwealth Pier 5	4,302	623	84	133	567
2. Fish Pier 6	570	105	4	9	103
3. Commonwealth Flats	3,011	542	46	103	509
4. Cabot, Cabot & Forbes (Northern Avenue Parcels)	1,503	249	7	16	251
5. Boston Wharf Company*	16	-89	-28	-126	0
6. Boston Marine Industrial Park	2,731	475	81	200	394
7. Fan Pier & Pier 4	16,494	1,299	407	580	1,492
Downtown Boston					
8. 500 Boylston Street	3,368	530	0	8	624
9. Rowes Wharf	3,340	240	81	126	226
10. International Place	4,656	770	0	18	800
11. Marketplace Center	1,059	283	0	16	327
12. 75 State Street	1,726	252	0	0	252
13. 101 Federal Street	1,334	224	0	4	232
14. 150 Federal Street	1,224	215	0	3	219
15. 99 Summer Street	681	128	3	7	128
16. South Station (Phase III)	4,579	359	128	191	375
17. 101 Arch Street	1,026	145	4	16	158
18. 20 & 21 Custom House Street	634	101	0	3	106
19. 125 Summer Street	1,229	218	0	2	222
20. Lincoln Street/Essex Street Site	937	158	0	3	163
21. Kingston Street/ Bedford Street Garage	1,762	316	0	3	320

* Negative values represent a reduction in trips from the loss of industrial uses and conversion of the space to other uses.

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Sources

1 Commonwealth Pier 5 Draft EIR

2-6 Calculated by Vanasse Hangen Brustlin, Inc.

7 Fan Pier & Pier 4 Final EIR

8 500 Boylston Street Final EIR

9 Rowes Wharf Final EIR

10-11 International Place Final EIR

12 99 State Street (now 75 State Street) Draft Traffic Study, Vanasse/Hangen, Inc.

13 Traffic Analyses by HMM Associates.

14 150 Federal Street Traffic Impact Study, Vanasse/Hangen, Inc.

15-17 Calculated by Vanasse Hangen Brustlin, Inc.

18 Milk and Broad Street Development Traffic Impact Study and Access Plan, Vanasse/Hangen, Inc., May, 1986

19 125 Summer Street, Transportation Impact Study and Access Plan, Vanasse/Hangen, Inc., July, 1986

20-21 Calculated by Vanasse Hangen Brustlin, Inc.

NEW ENGLAND TELEPHONE (NET)
REAL ESTATE OPERATIONS SURVEY

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REAL ESTATE OPERATIONS SURVEY

SEPTEMBER, 1988

PRESENT WORK LOCATION

Q1	FREQUENCY	PERCENT	CUMULATIVE FREQUENCY	CUMULATIVE PERCENT
185 FRANKLIN	161	37.8	161	37.8
285 FRANKLIN	52	12.2	213	50.0
99 HIGH	59	13.8	272	63.8
101 HUNTINGTON	125	29.3	397	93.2
100 SUMMER	29	6.8	426	100.0

PRIMARY MODE OF COMMUTING TO WORK NOW

Q2	FREQUENCY	PERCENT	CUMULATIVE FREQUENCY	CUMULATIVE PERCENT
PUBLIC TRANSIT	273	64.1	273	64.1
CAR POOL	34	8.0	307	72.1
VAN POOL	18	4.2	325	76.3
PERSONAL MV	88	20.7	413	96.9
OTHER	11	2.6	424	99.5
NO ANSWER	2	0.5	426	100.0

SAS

REAL ESTATE OPERATIONS SURVEY

SEPTEMBER, 1988

WHERE DO YOU USUALLY PARK?

Q2A	FREQUENCY	PERCENT	CUMULATIVE FREQUENCY	CUMULATIVE PERCENT
PO SQUARE (BOS)	30	7.0	30	7.0
NEWTON	2	0.5	32	7.5
NORTHERN AVE	26	6.1	58	13.6
265 FRLN GARAGE	2	0.5	60	14.1
SOUTH END	2	0.5	62	14.6
PRU CENTER GAR	26	6.1	88	20.7
ON STREET PRKNG	5	1.2	93	21.8
CHERI GARAGE	3	0.7	96	22.5
WESTLAND AVE	1	0.2	97	22.8
CHARLESTOWN	1	0.2	98	23.0
NORTH STATION	4	0.9	102	23.9
WINTHROP SQ GAR	2	0.5	104	24.4
ATLANTIC AVE	5	1.2	109	25.6
CAMBRIDGE	2	0.5	111	26.1
NECCO STREET	2	0.5	113	26.5
DEVONSHIRE SQ	3	0.7	116	27.2
CHURCH PK GAR	1	0.2	117	27.5
BOSTON COM GAR	1	0.2	118	27.7
BEDFORD ST	1	0.2	119	27.9
UNSPECIFIED GAR	6	1.4	125	29.3
RENTED PARKING	6	1.4	131	30.8
NOT APPLICABLE	277	65.0	408	95.8
NO ANSWER	18	4.2	426	100.0

REAL ESTATE OPERATIONS SURVEY

SEPTEMBER, 1986

FROM WHAT COUNTY DO YOU COMMUTE?

Q3COUNTY	FREQUENCY	PERCENT	CUMULATIVE FREQUENCY	CUMULATIVE PERCENT
BARNSTABLE	4	0.9	4	0.9
BRISTOL (MA)	12	2.8	16	3.8
DUKES	2	0.5	18	4.2
ESSEX	31	7.3	49	11.5
FRANKLIN	1	0.2	50	11.7
MIDDLESEX	113	26.5	163	38.3
NORFOLK	78	18.3	241	56.6
PLYMOUTH	29	6.8	270	63.4
SUFFOLK	79	18.5	349	81.9
WORCESTER	4	0.9	353	82.9
HILLSBOROUGH	3	0.7	356	83.6
MERRIMACK	1	0.2	357	83.8
ROCKINGHAM	6	1.4	363	85.2
BRISTOL (RI)	1	0.2	364	85.4
KENT	1	0.2	365	85.7
PROVIDENCE	6	1.4	371	87.1
NO ANSWER	55	12.9	426	100.0

FROM WHAT STATE DO YOU COMMUTE?

Q3STATE	FREQUENCY	PERCENT	CUMULATIVE FREQUENCY	CUMULATIVE PERCENT
MASSACHUSETTS	395	92.7	395	92.7
NEW HAMPSHIRE	12	2.8	407	95.5
RHODE ISLAND	12	2.8	419	98.4
NO ANSWER	7	1.6	426	100.0

NORMAL WORK START TIME

Q4	FREQUENCY	PERCENT	CUMULATIVE FREQUENCY	CUMULATIVE PERCENT
7:30 AM	87	20.4	87	20.4
8:00 AM	169	39.7	256	60.1
8:30 AM	132	31.0	388	91.1
OTHER	36	8.5	424	99.5
NO ANSWER	2	0.5	426	100.0

REAL ESTATE OPERATIONS SURVEY

SEPTEMBER, 1988

TABLE OF Q1 BY Q2

Q1(PRESENT WORK LOCATION)   Q2(PRIMARY MODE OF COMMUTING TO WORK NOW)

FREQUENCY / PERCENT / ROW PCT / COL PCT	PUBLIC TRANSIT	CAR POOL	VAN POOL	PERSONAL MV	OTHER	NO ANSWER	TOTAL
185 FRANKLIN	105	8	7	37	3	1	161
	24.65	1.88	1.64	8.69	0.70	0.23	37.79
	65.22	4.97	4.35	22.98	1.86	0.62	
	38.46	23.53	38.89	42.05	27.27	50.00	
265 FRANKLIN	36	4	1	10	1	0	52
	8.45	0.94	0.23	2.35	0.23	0.00	12.21
	69.23	7.69	1.92	19.23	1.92	0.00	
	13.19	11.76	5.56	11.36	9.09	0.00	
99 HIGH	46	2	3	7	1	0	59
	10.80	0.47	0.70	1.64	0.23	0.00	13.85
	77.97	3.39	5.08	11.86	1.69	0.00	
	16.85	5.88	16.67	7.95	9.09	0.00	
101 HUNTINGTON	67	17	6	29	6	0	125
	15.73	3.99	1.41	6.81	1.41	0.00	29.34
	53.60	13.60	4.80	23.20	4.80	0.00	
	24.54	50.00	33.33	32.95	54.55	0.00	
100 SUMMER	19	3	1	5	0	1	29
	4.46	0.70	0.23	1.17	0.00	0.23	6.81
	65.52	10.34	3.45	17.24	0.00	3.45	
	6.96	8.82	5.56	5.68	0.00	50.00	
TOTAL	273	34	18	88	11	2	426
	64.08	7.98	4.23	20.66	2.58	0.47	100.00

REAL ESTATE OPERATIONS SURVEY

SEPTEMBER, 1988

TABLE OF Q1 BY Q4

Q1(PRESENT WORK LOCATION)   Q4(NORMAL WORK START TIME)

FREQUENCY PERCENT ROW PCT COL PCT	7:30 AM	8:00 AM	8:30 AM	OTHER	NO ANSWER	TOTAL
186 FRANKLIN	35 8.22 21.74 40.23	55 12.91 34.16 32.54	46 10.80 28.57 34.85	24 5.63 14.91 66.67	1 0.23 0.62 50.00	161 37.79
266 FRANKLIN	17 3.99 32.69 19.54	20 4.69 38.46 11.83	12 2.82 23.08 9.09	3 0.70 5.77 8.33	0 0.00 0.00 0.00	52 12.21
89 HIGH	9 2.11 15.25 10.34	30 7.04 50.85 17.75	17 3.99 28.81 12.88	3 0.70 5.08 8.33	0 0.00 0.00 0.00	59 13.85
101 HUNTINGTON	23 5.40 18.40 26.44	45 10.56 36.00 26.63	51 11.97 40.80 38.64	5 1.17 4.00 13.89	1 0.23 0.80 50.00	125 29.34
100 SUMMER	3 0.70 10.34 3.45	19 4.46 65.52 11.24	6 1.41 20.69 4.55	1 0.23 3.45 2.78	0 0.00 0.00 0.00	29 6.81
TOTAL	87 20.42	169 39.67	132 30.99	36 8.45	2 0.47	426 100.00

PEDESTRIAN
LEVEL OF SERVICE ANALYSIS

WALKWAY ANALYSIS WORKSHEET

Location: 125 HIGH STREET - HIGH ST.

City, State: BOSTON, MA

COUNTS

Date: 9-25-86

Time: 7:45 - 8:45 AM

Curb Line/Sidewalk Edge

PEAK 15-MIN FROM

8:00 to 8:15

W_T = 22.5

W_{B1} (curb) =	1.5	ft
W_{B2} (street furn.) =	0	ft
W_E (effective width) =	9	ft
W_{B3} (window shop) =	3	ft
W_{B4} (bldg protrusions) =	9	ft
W_{B5} (inside clearance =	0	ft

V_1 = –

V_2 = –

(ped/15 min)

Wall Line/Sidewalk Edge

Pedestrian Volume

1044 ÷ 4 =
261

V_1 = – ped/15 min

V_2 = – ped/15 min

$V_p = V_1 + V_2$ = 261 ped/15 min

Walkway Width

W_T = 22.5 ft

$W_B = W_{B1} + W_{B2} + W_{B3} + W_{B4} + W_{B5}$ = 13.5 ft

$W_E = W_T - W_B$ = 9 ft

Average Walkway LOS

$v = V_p/15W_E$ = 1.9 ped/min/ft

Average LOS = A (Table 13-3)

Platoon Walkway LOS

$v_p = v + 4$ = 5.9 ped/min/ft

Platoon LOS = B (Table 13-3)

WALKWAY ANALYSIS WORKSHEET

Location: 125 HIGH STREET – HIGH ST.

City, State: BOSTON, MA

COUNTS

Date: 9-25-86

Time: 4:15 – 5:15 PM

PEAK 15-MIN FROM 4:30 to 4:45

Curb Line/Sidewalk Edge

W_T = 22.5

W_{B1} (curb) =	1.5	ft
W_{B2} (street furn.) =	0	ft
W_E (effective width) =	9	ft
W_{B3} (window shop) =	3	ft
W_{B4} (bldg protrusions) =	9	ft
W_{B5} (inside clearance =	0	ft

Wall Line/Sidewalk Edge

← V_1 = –

→ V_2 = –

(ped/15 min)

Pedestrian Volume

1290 ÷ 4 =
322.5

V_1 = – ped/15 min

V_2 = – ped/15 min

$V_p = V_1 + V_2$ = 323 ped/15 min

Walkway Width

W_T = 22.5 ft

$W_B = W_{B1} + W_{B2} + W_{B3} + W_{B4} + W_{B5}$ = 13.5 ft

$W_E = W_T - W_B$ = 9 ft

Average Walkway LOS

$v = V_p/15W_E$ = 2.4 ped/min/ft

Average LOS = B (Table 13-3)

Platoon Walkway LOS

$v_p = v + 4$ = 6.4 ped/min/ft

Platoon LOS = B (Table 13-3)

WALKWAY ANALYSIS WORKSHEET

Location: 125 HIGH STREET - PEARL ST. WEST
COUNTS

City, State: BOSTON, MA

Date: 9-25-86
Time: 7:45 - 8:45 AM

Curb Line/Sidewalk Edge

PEAK 15-MIN FROM 8:00 to 8:15

W_{B1} (curb) =	1.5	ft
W_{B2} (street furn.) =	0	ft
W_T = 23.5 W_E (effective width) =	12.5	ft
W_{B3} (window shop) =	0	ft
W_{B4} (bldg protrusions) =	11	ft
W_{B5} (inside clearance =	0	ft

V_1 = –

V_2 = –

(ped/15 min)

Wall Line/Sidewalk Edge

Pedestrian Volume

1185 ÷ 4 =
296

$V_1 =$ – ped/15 min

$V_2 =$ – ped/15 min

$V_p = V_1 + V_2 =$ 296 ped/15 min

Walkway Width

$W_T =$ 23.5 ft

$W_B = W_{B1} + W_{B2} + W_{B3} + W_{B4} + W_{B5} =$ 12.5 ft

$W_E = W_T - W_B =$ 11 ft

Average Walkway LOS

$v = V_p/15W_E =$ 1.8 ped/min/ft

Average LOS = A (Table 13-3)

Platoon Walkway LOS

$v_p = v + 4 =$ 5.8 ped/min/ft

Platoon LOS = B (Table 13-3)

WALKWAY ANALYSIS WORKSHEET

Location: 125 HIGH STREET – PEARL ST. WEST COUNTS

City, State: BOSTON, MA

Date: 9-25-86

Time: 4:15 - 5:15 PM

Curb Line/Sidewalk Edge

PEAK 15-MIN FROM 4:30 to 4:45

W_T = 23.5

W_{B1} (curb) =	1.5	ft
W_{B2} (street furn.) =	0	ft
W_E (effective width) =	12.5	ft
W_{B3} (window shop) =	0	ft
W_{B4} (bldg protrusions) =	11	ft
W_{B5} (inside clearance =	0	ft

V_1 = –

V_2 = –

(ped/15 min)

Wall Line/Sidewalk Edge

Pedestrian Volume

1183 ÷ 4 = 296

V_1 = – ped/15 min

V_2 = – ped/15 min

$V_p = V_1 + V_2$ = 296 ped/15 min

Walkway Width

W_T = 23.5 ft

$W_B = W_{B1} + W_{B2} + W_{B3} + W_{B4} + W_{B5}$ = 12.5 ft

$W_E = W_T - W_B$ = 11 ft

Average Walkway LOS

$v = V_p/15W_E$ = 1.8 ped/min/ft

Average LOS = A (Table 13-3)

Platoon Walkway LOS

$v_p = v + 4$ = 5.8 ped/min/ft

Platoon LOS = B (Table 13-3)

WALKWAY ANALYSIS WORKSHEET

Location: 125 HIGH STREET – PEARL ST. EAST

City, State: BOSTON, MA

COUNTS

Date: 9-25-86

Time: 8:00 - 9:00 AM

PEAK 15-MIN FROM 8:15 to 8:30

Curb Line/Sidewalk Edge

W_T = 23.5

W_{B1} (curb) =	1.5 ft
W_{B2} (street furn.) =	0 ft
W_E (effective width) =	12.5 ft
W_{B3} (window shop) =	0 ft
W_{B4} (bldg protrusions) =	11 ft
W_{B5} (inside clearance =	0 ft

Wall Line/Sidewalk Edge

← V_1 = –

→ V_2 = –

(ped/15 min)

Pedestrian Volume

525 ÷ 4 =

131

V_1 = – ped/15 min

V_2 = – ped/15 min

$V_p = V_1 + V_2 =$ 131 ped/15 min

Walkway Width

$W_T =$ 23.5 ft

$W_B = W_{B1} + W_{B2} + W_{B3} + W_{B4} + W_{B5} =$ 12.5 ft

$W_E = W_T - W_B =$ 11 ft

Average Walkway LOS

$v = V_p/15W_E =$ 0.8 ped/min/ft

Average LOS = A (Table 13-3)

Platoon Walkway LOS

$v_p = v + 4 =$ 4.8 ped/min/ft

Platoon LOS = B (Table 13-3)

WALKWAY ANALYSIS WORKSHEET

Location: 125 HIGH STREET – PEARL ST. EAST

COUNTS

City, State: BOSTON, MA

Date: 9-25-86

Time: 4:15 - 5:15 PM

Curb Line/Sidewalk Edge

PEAK 15-MIN FROM 5:00 to 5:15

W_{B1} (curb) = 1.5 ft

W_{B2} (street furn.) = 0 ft

W_T = 23.5 W_E (effective width) = 12.5 ft

V_1 = –

W_{B3} (window shop) = 0 ft

V_2 = – (ped/15 min)

W_{B4} (bldg protrusions) = 11 ft

W_{B5} (inside clearance = 0 ft

Wall Line/Sidewalk Edge

Pedestrian Volume

1676 ÷ 4 = 419

$V_1 =$ – ped/15 min

$V_2 =$ – ped/15 min

$V_p = V_1 + V_2 =$ 419 ped/15 min

Walkway Width

$W_T =$ 23.5 ft

$W_B = W_{B1} + W_{B2} + W_{B3} + W_{B4} + W_{B5} =$ 12.5 ft

$W_E = W_T - W_B =$ 11 ft

Average Walkway LOS

$v = V_p/15W_E =$ 2.5 ped/min/ft

Average LOS = B (Table 13-3)

Platoon Walkway LOS

$v_p = v + 4 =$ 6.5 ped/min/ft

Platoon LOS = B (Table 13-3)

WALKWAY ANALYSIS WORKSHEET

Location: 125 HIGH STREET – PURCHASE STREET

COUNTS

City, State: BOSTON, MA

Date: 9-25-86

Time: 8:00 - 9:00 AM

PEAK 15-MIN FROM 8:15 to 8:30

Curb Line/Sidewalk Edge

W_T = 16

W_{B1} (curb) =	1.5	ft
W_{B2} (street furn.) =	0	ft
W_E (effective width) =	3.5	ft
W_{B3} (window shop) =	0	ft
W_{B4} (bldg protrusions) =	2	ft
W_{B5} (inside clearance =	0	ft

Wall Line/Sidewalk Edge

V_1 = –

V_2 = –

(ped/15 min)

Pedestrian Volume

1464 ÷ 4 =

366

V_1 = – ped/15 min

V_2 = – ped/15 min

$V_p = V_1 + V_2$ = 366 ped/15 min

Walkway Width

W_T = 16 ft

$W_B = W_{B1} + W_{B2} + W_{B3} + W_{B4} + W_{B5}$ = 3.5 ft

$W_E = W_T - W_B$ = 12.5 ft

Average Walkway LOS

$v = V_p/15W_E$ = 1.9 ped/min/ft

Average LOS = A (Table 13-3)

Platoon Walkway LOS

$v_p = v + 4$ = 5.9 ped/min/ft

Platoon LOS = B (Table 13-3)

WALKWAY ANALYSIS WORKSHEET

Location: 125 HIGH STREET – PURCHASE ST.

City, State: BOSTON, MA

COUNTS

Date: 9-25-86

Time: 4:15 – 5:15 PM

PEAK 15-MIN FROM

5:00 to 5:15

Curb Line/Sidewalk Edge

W_T = 16

W_{B1} (curb) =	1.5	ft
W_{B2} (street furn.) =	0	ft
W_E (effective width) =	3.5	ft
W_{B3} (window shop) =	0	ft
W_{B4} (bldg protrusions) =	2	ft
W_{B5} (inside clearance =	0	ft

← V_1 = –

→ V_2 = –

(ped/15 min)

Wall Line/Sidewalk Edge

Pedestrian Volume

1374 ÷ 4 =

343.5

V_1 = – ped/15 min

V_2 = – ped/15 min

$V_p = V_1 + V_2$ = 344 ped/15 min

Walkway Width

W_T = 16 ft

$W_B = W_{B1} + W_{B2} + W_{B3} + W_{B4} + W_{B5}$ = 3.5 ft

$W_E = W_T - W_B$ = 12.5 ft

Average Walkway LOS

$v = V_p/15W_E$ = 1.8 ped/min/ft

Average LOS = A (Table 13-3)

Platoon Walkway LOS

$v_p = v + 4$ = 5.8 ped/min/ft

Platoon LOS = B (Table 13-3)

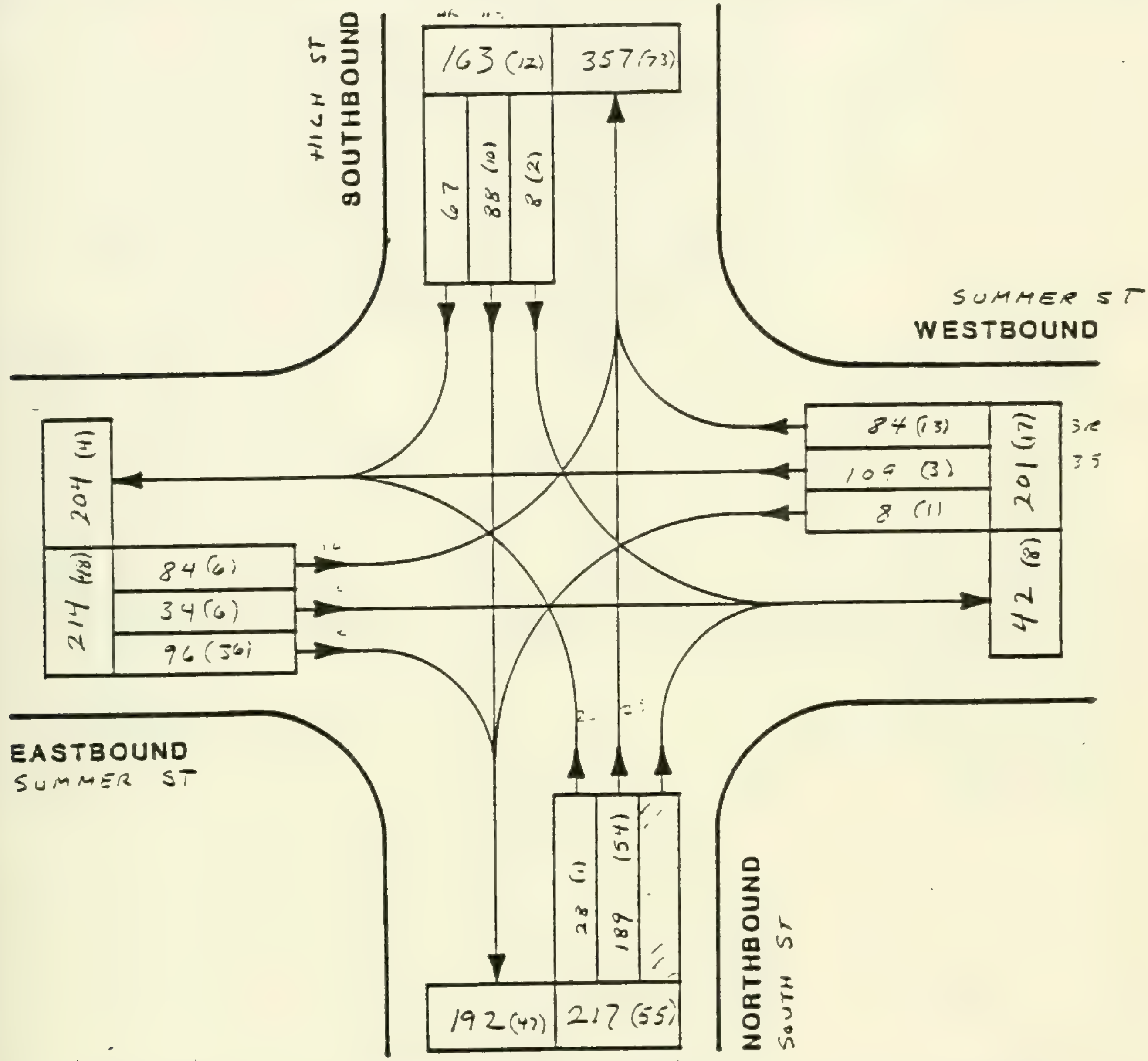
STUDY INTERSECTION
TURNING MOVEMENT COUNTS

1602/487/wpr

Vanasse/Hangen
Consulting Engineers & Planners
60 Birmingham Parkway, Boston, MA 02135
617/783-7000

INTERSECTION TURNING MOVEMENT COUNT

CITY Boston, MA DATE 9/17/86 DAY of WEEK Wednesday
INTERSECTION Summer / High / South JOB No. 1602

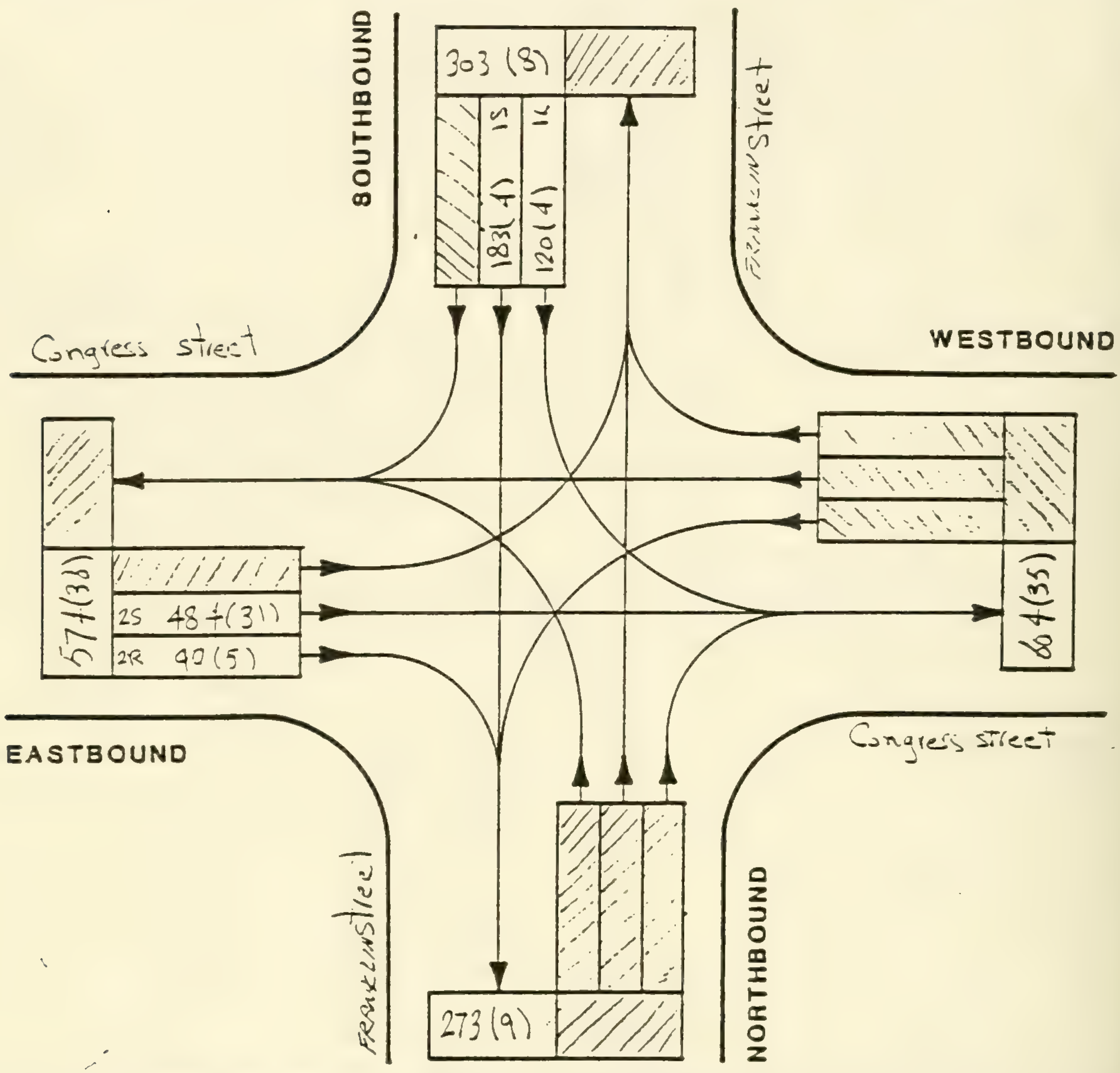


STREET	ENTERING VOLUME	PERCENT OF FLOW	TIME of COUNT
South St (Northbound)	217 (55)		4 - 5 PM
High St (Southbound)	163 (12)		
Summer St (Eastbound)	214 (48)		PM PEAK HOUR
Summer St (Westbound)	201 (17)		
			VEHICLES COUNTED
			ALL VEHICLES XXX
			TRUCKS (XX)
TOTAL	795 (132)		PERCENT TRUCKS 16.6 %

VH
Vanasse/Hangen
Consulting Engineers & Planners
60 Birmingham Parkway, Boston, MA 02135
617/783-7000

INTERSECTION TURNING MOVEMENT COUNT

CITY Boston MASS DATE Sept 1985 DAY of WEEK Friday
INTERSECTION Congress street / Franklin street JOB No. 1602



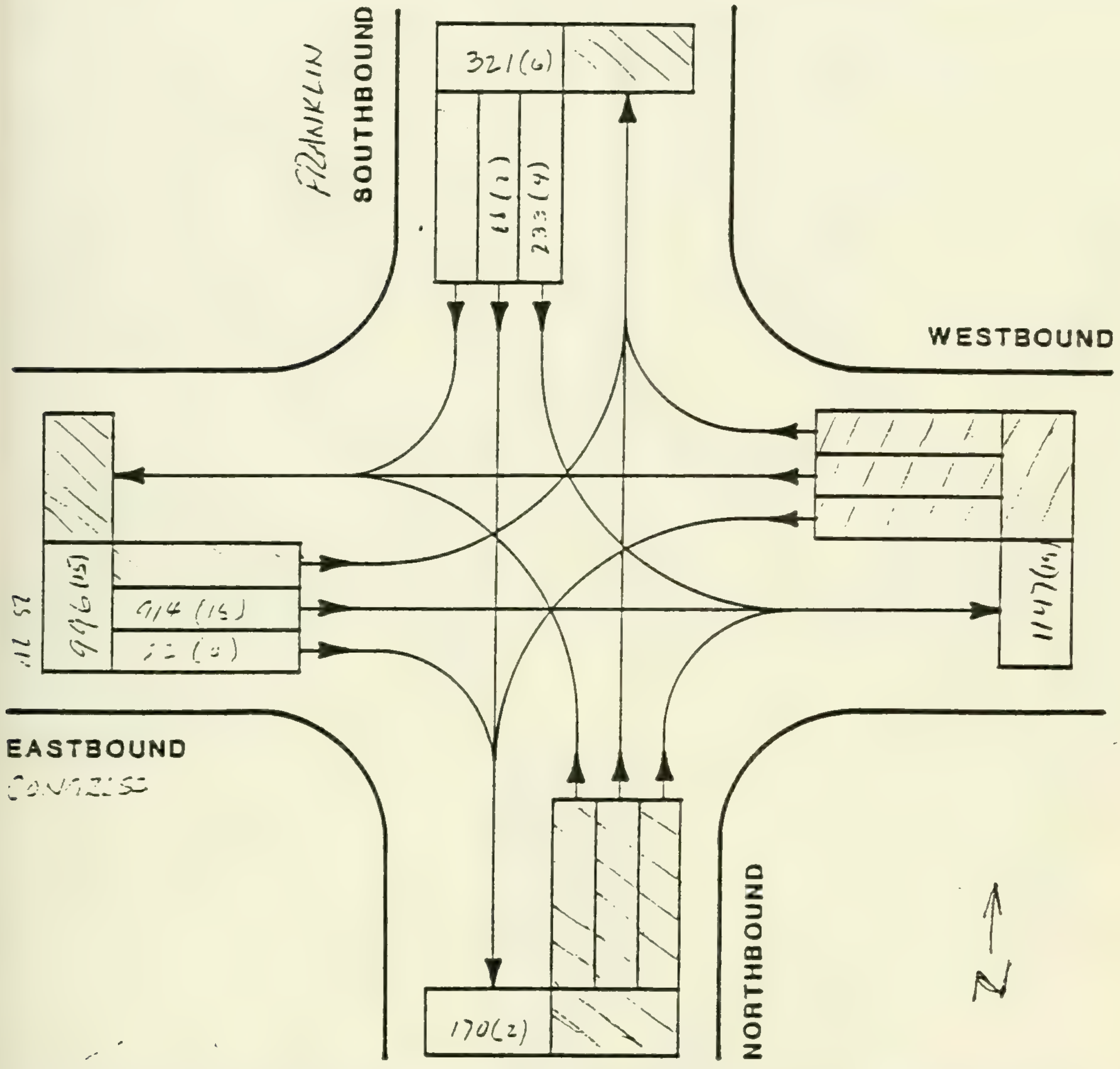
STREET	ENTERING VOLUME	PERCENT OF FLOW	TIME of COUNT
High street southbound	303 (8)	34.55	7:45 AM – 8:45 AM
Congress street Eastbound	574 (36)	65.45	
			AM Peak hour
			VEHICLES COUNTED
			ALL VEHICLES XXX
			TRUCKS (XX)
TOTAL	877 (44)	100	PERCENT TRUCKS 5.1 %

Vanasse/Hangen
Consulting Engineers & Planners
60 Birmingham Parkway, Boston, MA 02135
617/783-7000

INTERSECTION TURNING MOVEMENT COUNT

CITY Boston, Mass DATE 9/15 DAY of WEEK Monday

INTERSECTION Franklin & Congress JOB No. 1602



STREET	ENTERING VOLUME	PERCENT OF FLOW	TIME of COUNT
FRANKLIN Southbound	321(6)	24.4 %	5:15 – 6:00 PM
CONGRESS Eastbound	996(15)	75.6 %	
			PM PEAK HOUR
			VEHICLES COUNTED
			ALL VEHICLES XXX 1317
			TRUCKS (XX) 21
TOTAL	1317(21)	100	PERCENT TRUCKS 1.6 %

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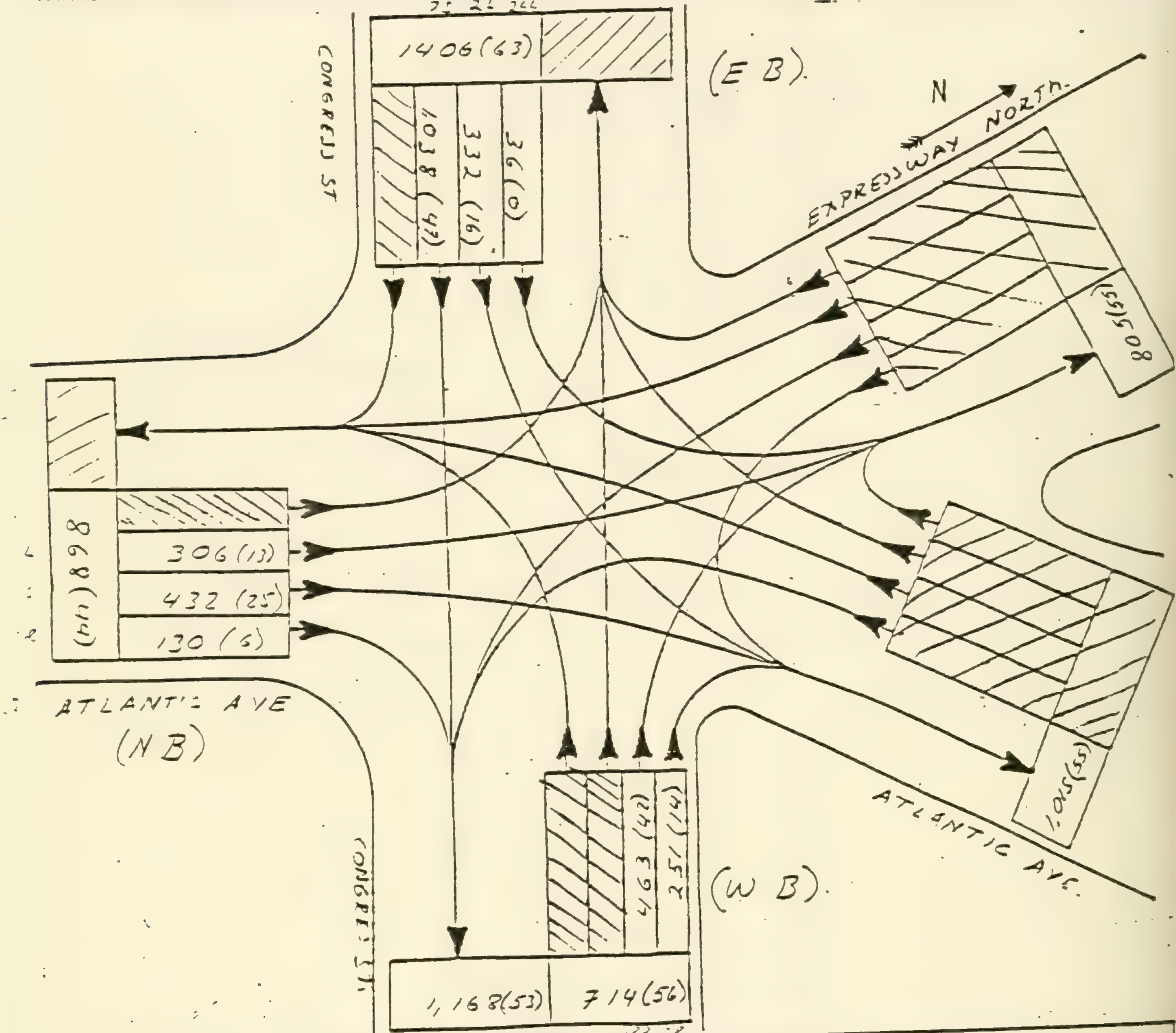
60 Birmingham Parkway, Boston, MA 02135
617/783-7000

INTERSECTION TURNING MOVEMENT COUNT

CITY Boston, MA. DATE 9/17/86 DAY of WEEK WEDNESDAY
INTERSECTION Atlantic Ave / Congress St JOB No. NE TEL

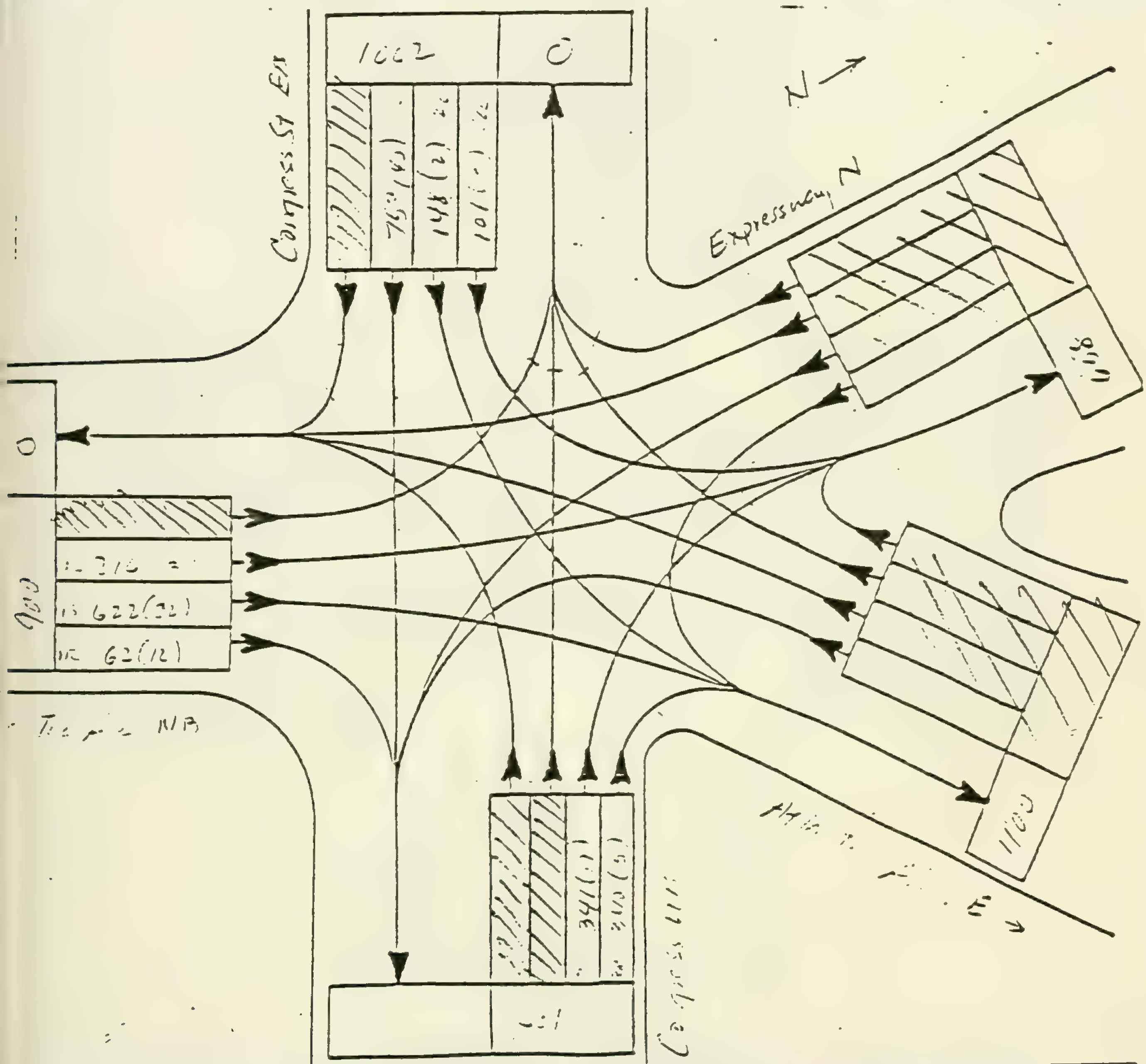


STREET	ENTERING VOLUME	PERCENT OF FLOW	TIME of COUNT
Atlantic Ave (NB)	868 (44)	29.0 %	7:15 - 8:15 AM.
Congress St (EB)	1,406 (63)	47.1 %	
Congress St (WB)	714 (56)	23.9 %	PEAK.
			VEHICLES COUNTED
			ALL VEHICLES XXX
			TRUCKS (XX)
TOTAL	2,988 (163)	100 %	PERCENT TRUCKS %

VH Vanasse/Hangen
Consulting Engineers & Planners
60 Birmingham Parkway, Boston, MA 02135
617/783-7000

INTERSECTION TURNING MOVEMENT COUNT

CITY Boston DATE [illegible] DAY of WEEK Thursday
INTERSECTION [illegible] JOB No. [illegible]

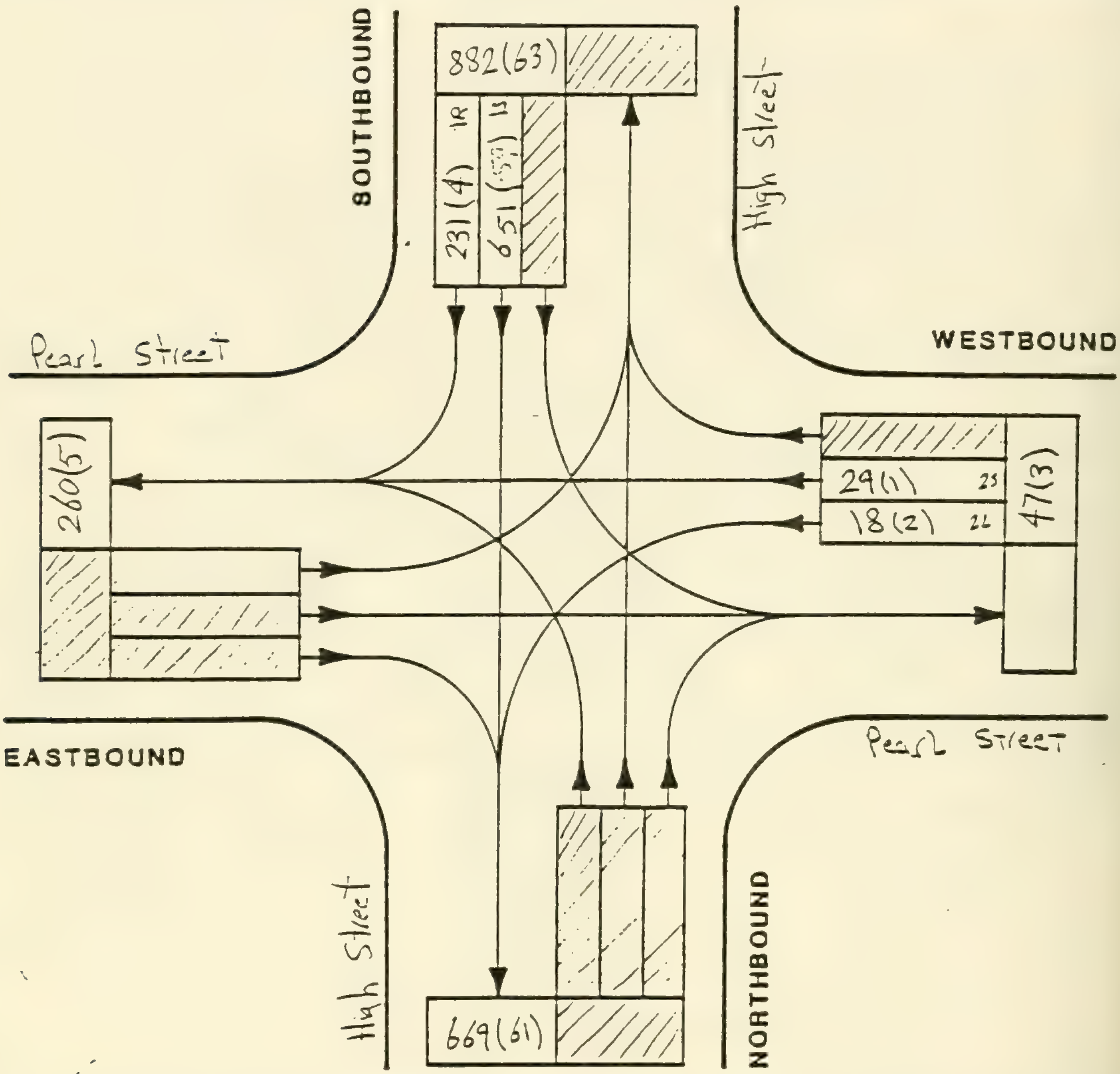


STREET	ENTERING VOLUME	PERCENT OF FLOW	TIME of COUNT
[illegible]	900	34.47	4:45 PM – 5:45 PM
[illegible] EB	1002	38.19	
[illegible] WB	641	26.36	
			VEHICLES COUNTED
			ALL VEHICLES XXX 2543
			TRUCKS (XX) 302
TOTAL	2543	99.99	PERCENT TRUCKS 11.7 %

Vanasse/Hangen
Consulting Engineers & Planners
60 Birmingham Parkway, Boston, MA 02135
617/783-7000

INTERSECTION TURNING MOVEMENT COUNT

CITY Boston MA DATE Sept 11 86 DAY of WEEK Thursday
INTERSECTION High Street / Pearl Street JOB No. 1607

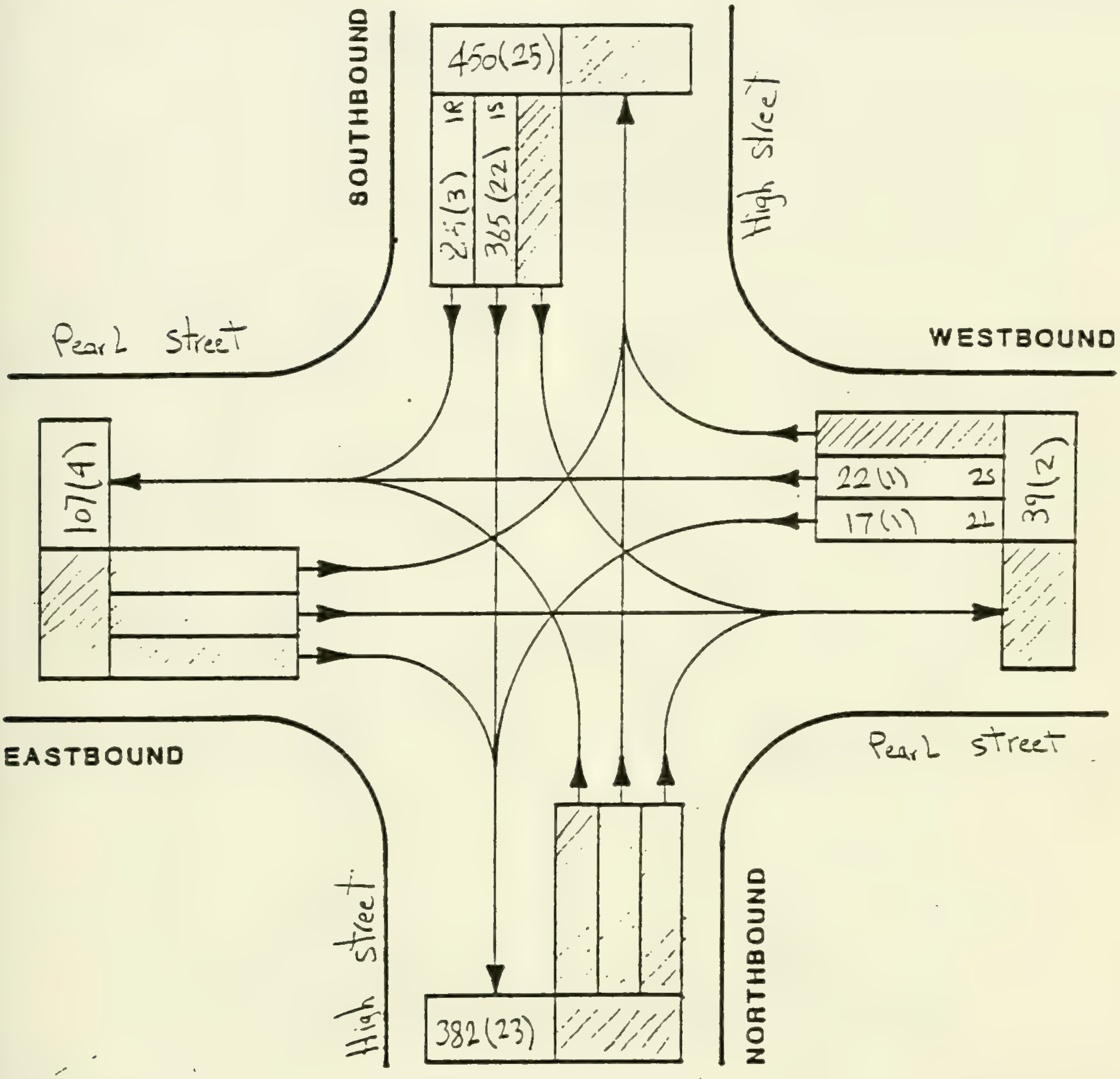


STREET	ENTERING VOLUME	PERCENT OF FLOW	TIME of COUNT
High Street Southbound	882 (63)	94.94	7:45 AM - 8:45 AM
Pearl Street Westbound	47 (3)	5.06	
			AM Peak hour
			VEHICLES COUNTED
			ALL VEHICLES XXX
			TRUCKS (XX)
TOTAL	929 (66)	100	PERCENT TRUCKS 7.1 %

VH
Vanasse/Hangen
Consulting Engineers & Planners
60 Birmingham Parkway, Boston, MA 02135
617/783-7000

INTERSECTION TURNING MOVEMENT COUNT

CITY Boston MA DATE sept 10 86 DAY of WEEK Wednesday
INTERSECTION High street / Pearl street JOB No. 1602

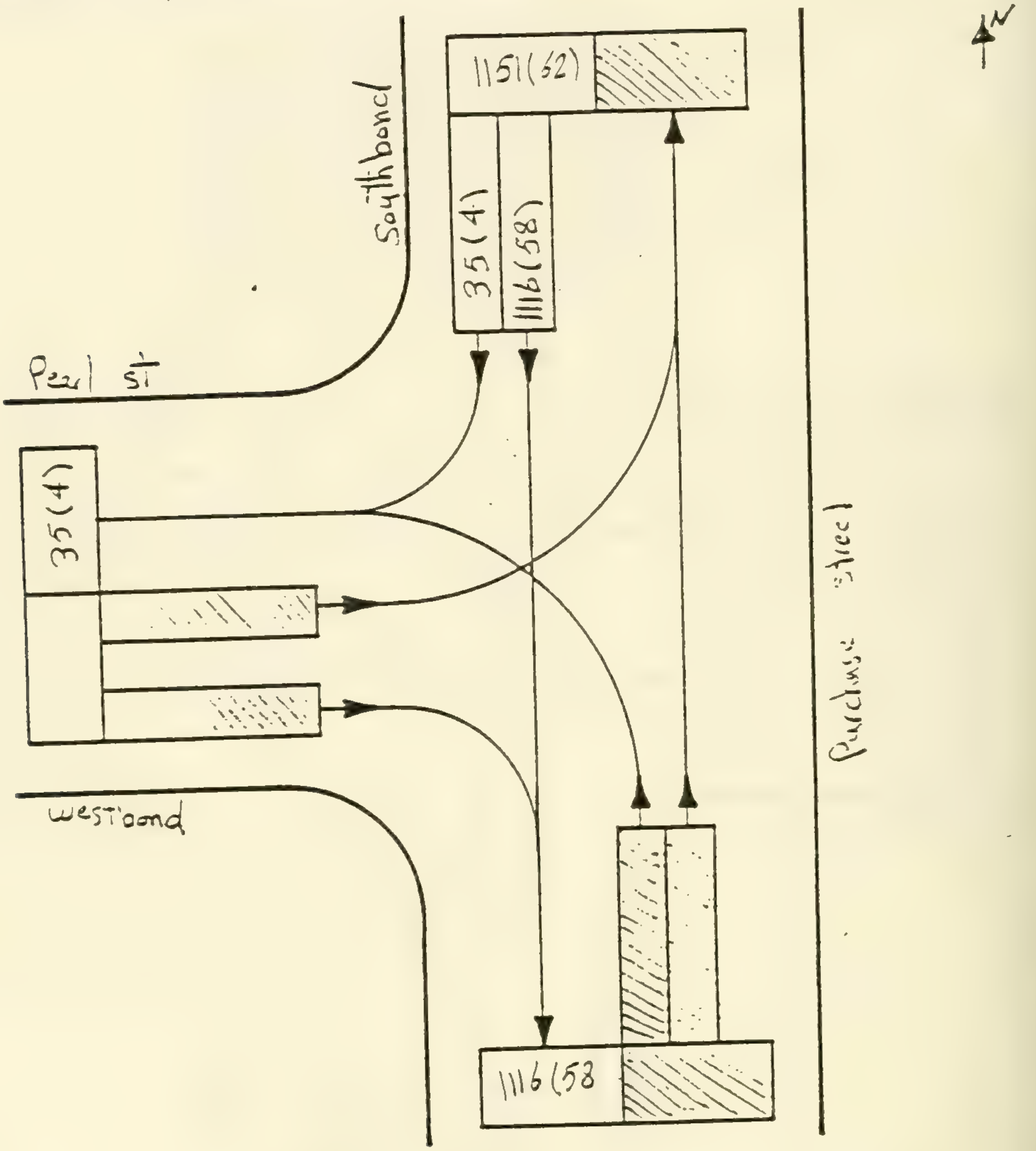


STREET	ENTERING VOLUME	PERCENT OF FLOW	TIME of COUNT
High street Southbound	450 (25)	92.02	4:45 PM - 5:45 PM
Pearl street Westbound	39 (2)	7.98	
			PM Peak hour
			VEHICLES COUNTED
			ALL VEHICLES XXX
			TRUCKS (XX)
TOTAL	489 (27)	100	PERCENT TRUCKS [illegible] %

Vanasse/Hangen
Consulting Engineers & Planners
60 Birmingham Parkway, Boston, MA 02135
617/783-7000

INTERSECTION TURNING MOVEMENT COUNT

CITY Boston MASS DATE 9/1-/86 DAY of WEEK Wed
INTERSECTION Pearl St / Purchase st JOB No. 1602



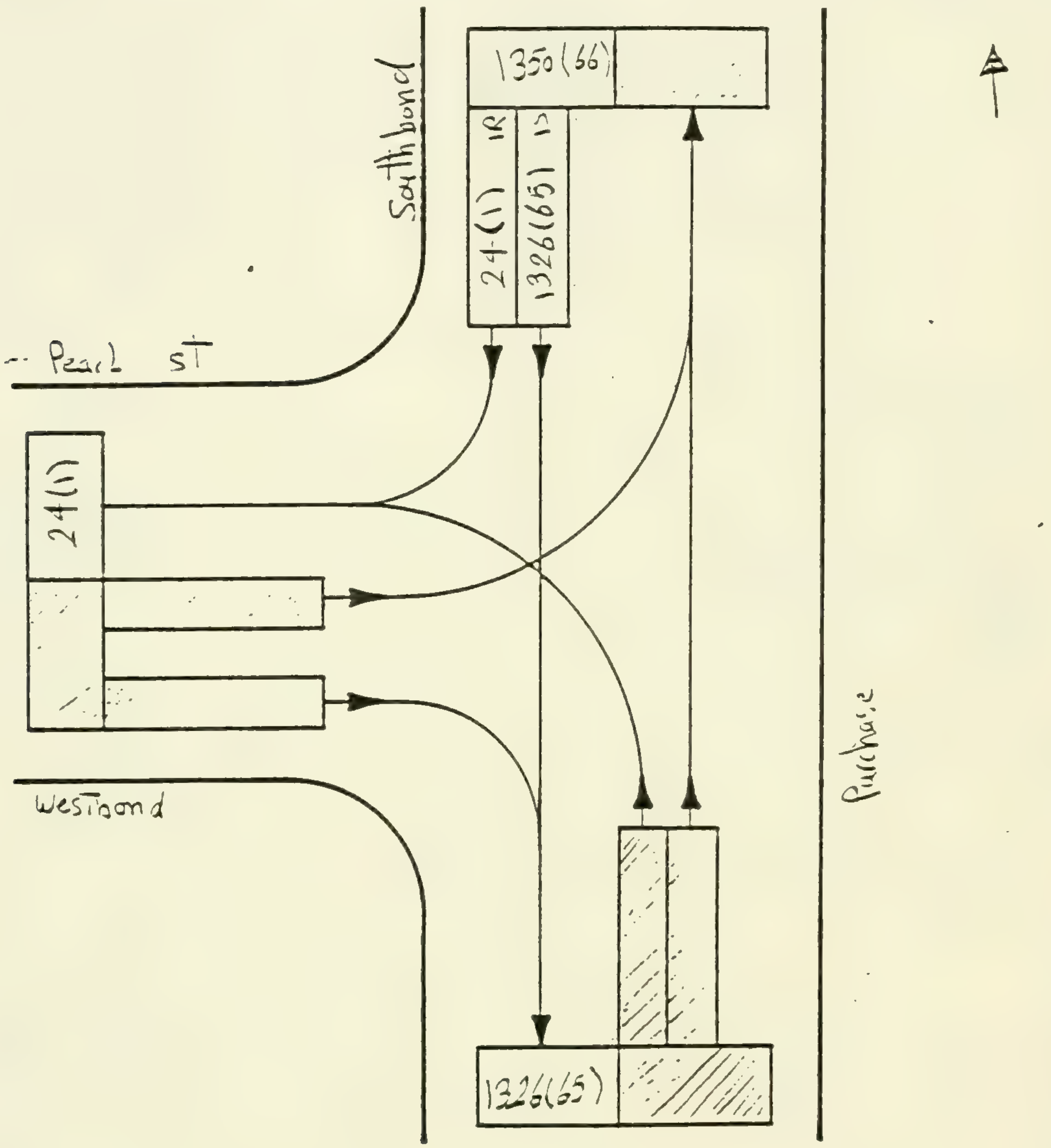
STREET	ENTERING VOLUME	PERCENT OF FLOW	TIME of COUNT
Purchase Street Southbond	1151 (62)	100	7:45 AM - 8:45 AM
			AM Peak hour
			VEHICLES COUNTED
			ALL VEHICLES XXX
			TRUCKS (XX)
			PERCENT TRUCKS 5.4 %
TOTAL	1151 (62)	100	

Vanasse/Hangen
Consulting Engineers & Planners
60 Birmingham Parkway, Boston, MA 02135
617/783-7000

INTERSECTION TURNING MOVEMENT COUNT

CITY Boston MASS DATE 6/10/91 DAY of WEEK Tuesday

INTERSECTION Pearl st / purchase st JOB No. 1602

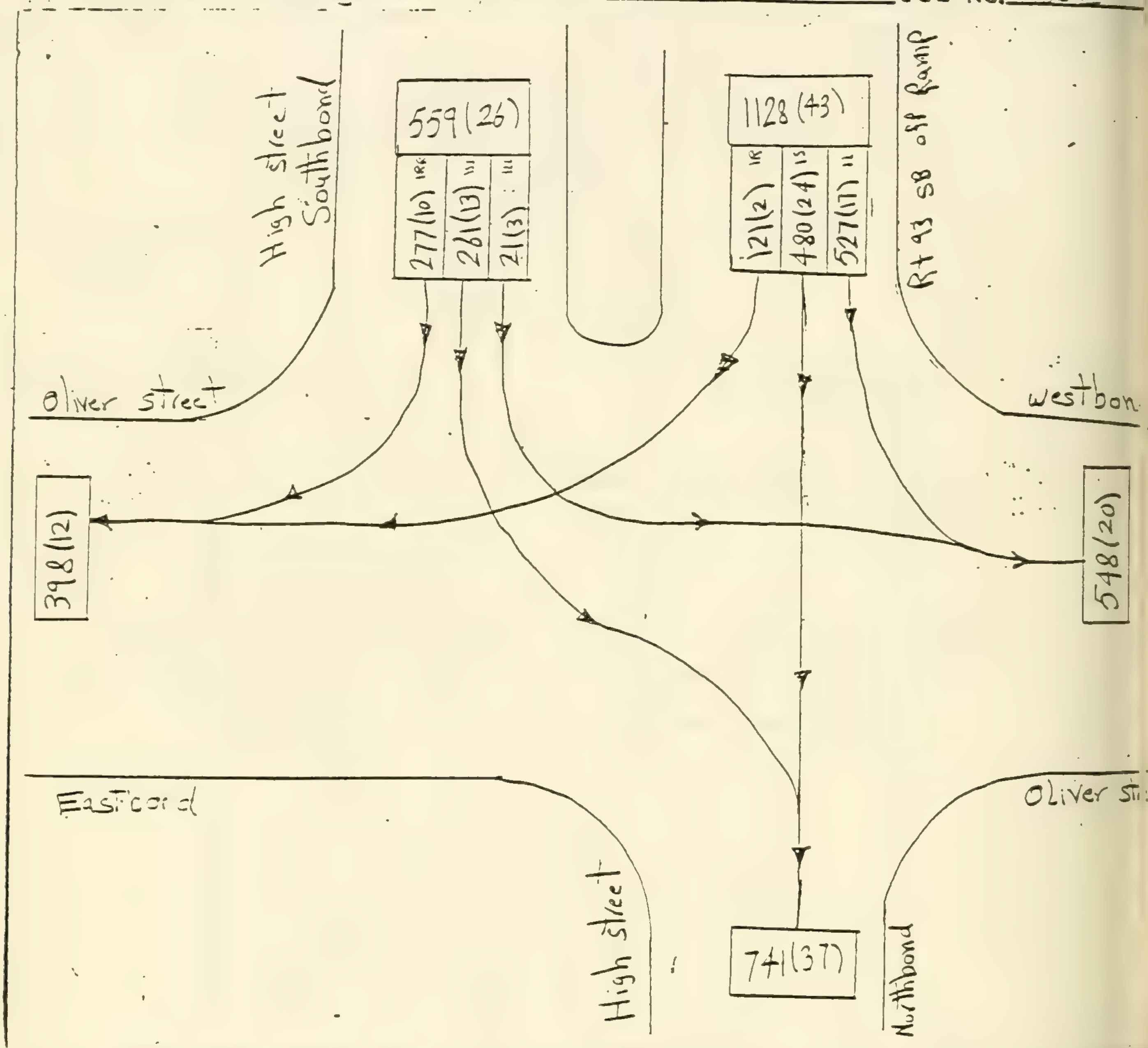


STREET	ENTERING VOLUME	PERCENT OF FLOW	TIME of COUNT
Purchase Southbound	1350 (66)	100	4:45 PM - 5:45 PM
			PM Peak hour
			VEHICLES COUNTED
			ALL VEHICLES XXX
			TRUCKS (XX)
TOTAL	1350 (66)	100	PERCENT TRUCKS — %

Transportation Engineers & Planners
184 High Street, Boston, Massachusetts 02110
617 / 482-0749

INTERSECTION TURNING MOVEMENT COUNT

CITY: Boston MASS DATE: sept 17 86 DAY of WEEK: Wedn
INTERSECTION: High street / oliver street JOB No. 1602

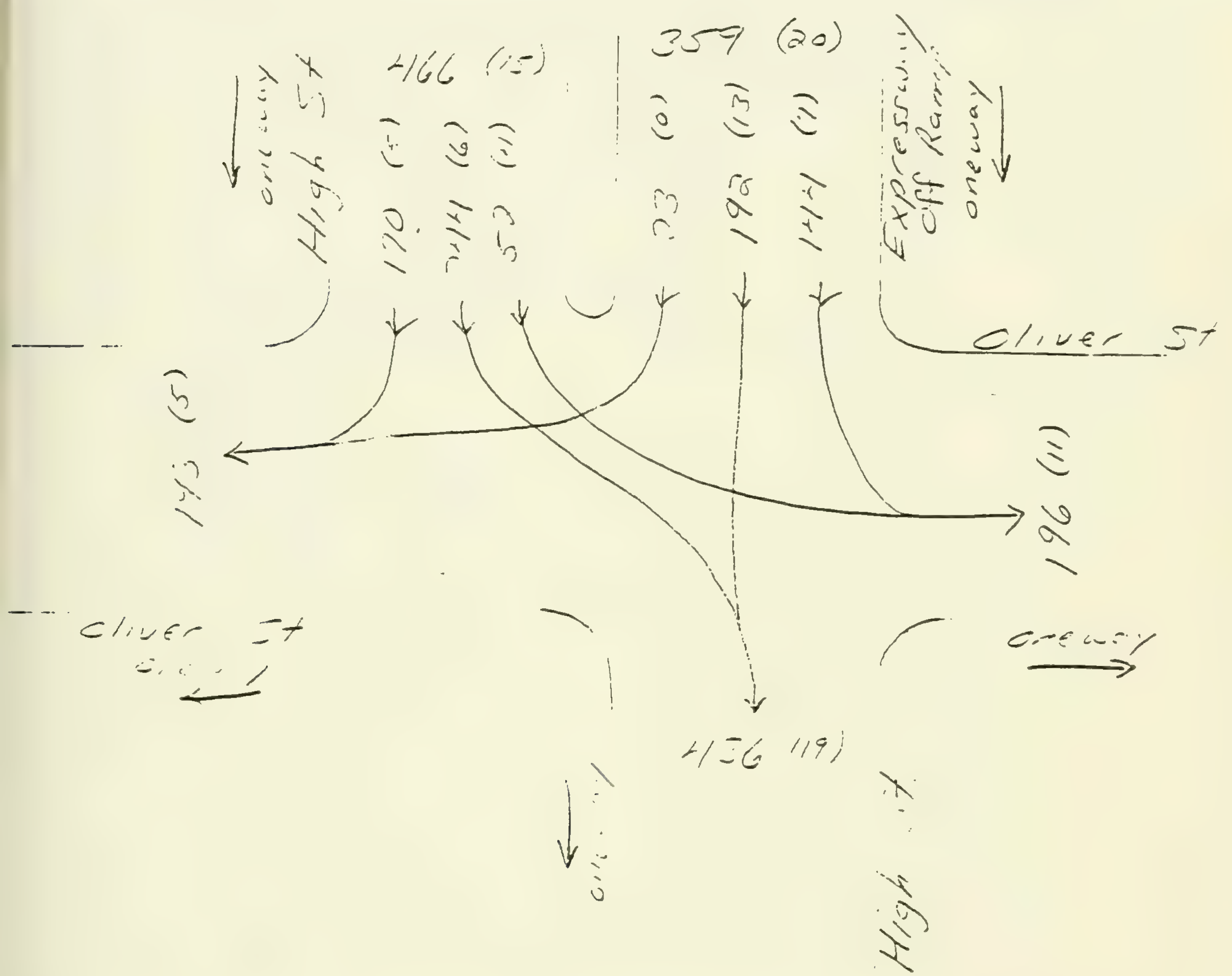


STREET	ENTERING VOLUME	PERCENT OF FLOW	TIME of COUNT
High street Southbond	559 (26)	33.14	7:45 AM - 8:45 AM
RTE 93 SB off ramp Southbond	1128 (43)	66.86	
			AM Peak hour
			VEHICLES COUNTED
			ALL VEHICLES XXX
			TRUCKS (XX)
TOTAL	1687(69)	100	PERCENT TRUCKS

VH Vanasse/Hangen
Consulting Engineers & Planners
60 Birmingham Parkway, Boston, MA 02135
617/783-7000

INTERSECTION TURNING MOVEMENT COUNT

CITY Canton, MA DATE 9/10/86 DAY of WEEK Wednesday
INTERSECTION High St / Oliver St JOB No. 1602

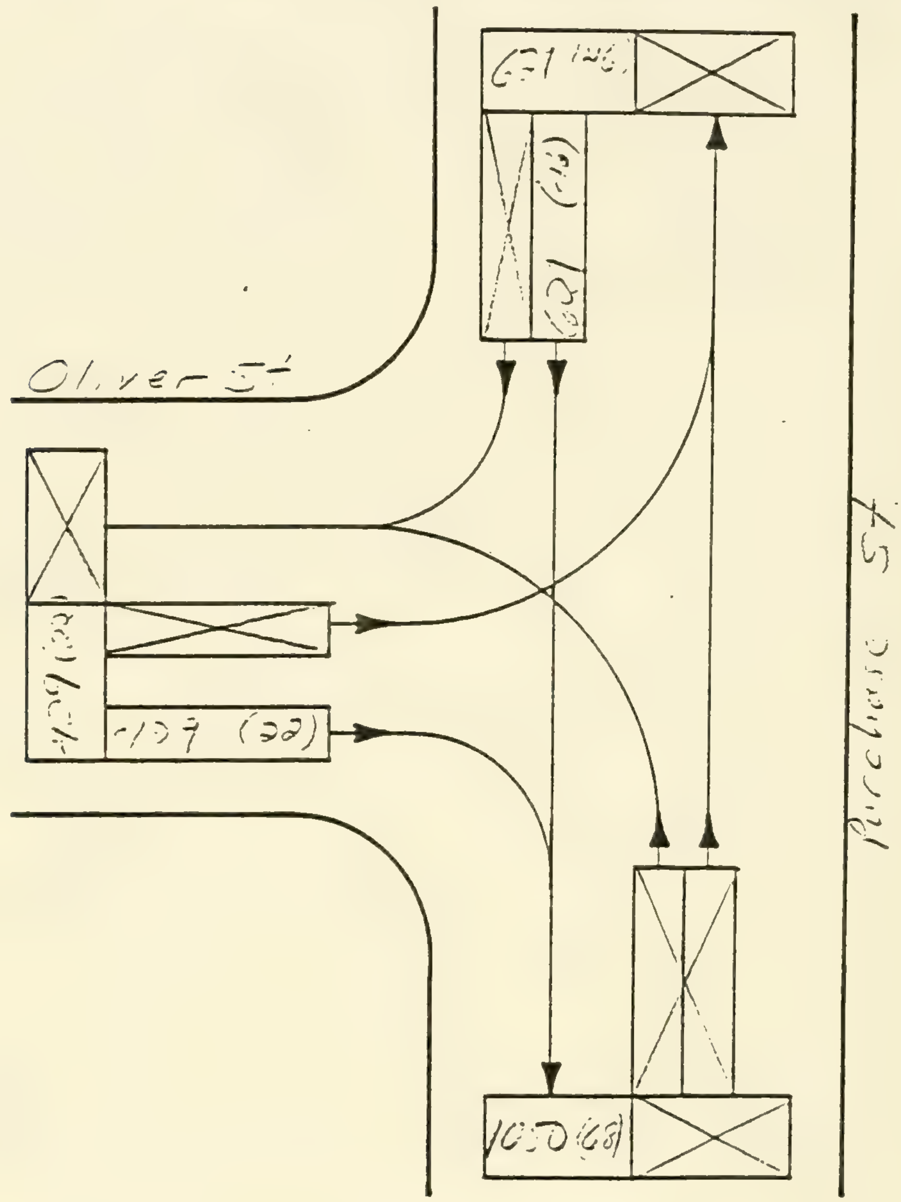


STREET	ENTERING VOLUME	PERCENT OF FLOW	TIME of COUNT
High St	466 (15)	56.5	5:00 to 6:00
Expressway Ramp	359 (20)	43.5	
			PM Peak Hour
			VEHICLES COUNTED
			ALL VEHICLES XXX [illegible]
			TRUCKS (XX) [illegible]
TOTAL	825 (35)	100.0	PERCENT TRUCKS 4.2 %

VH Vanasse/Hangen
Consulting Engineers & Planners
60 Birmingham Parkway, Boston, MA 02135
617/783-7000

INTERSECTION TURNING MOVEMENT COUNT

CITY Boston MA DATE 9/[illegible] DAY of WEEK Wednesday
INTERSECTION Purchase St / Oliver St JOB No. 1636



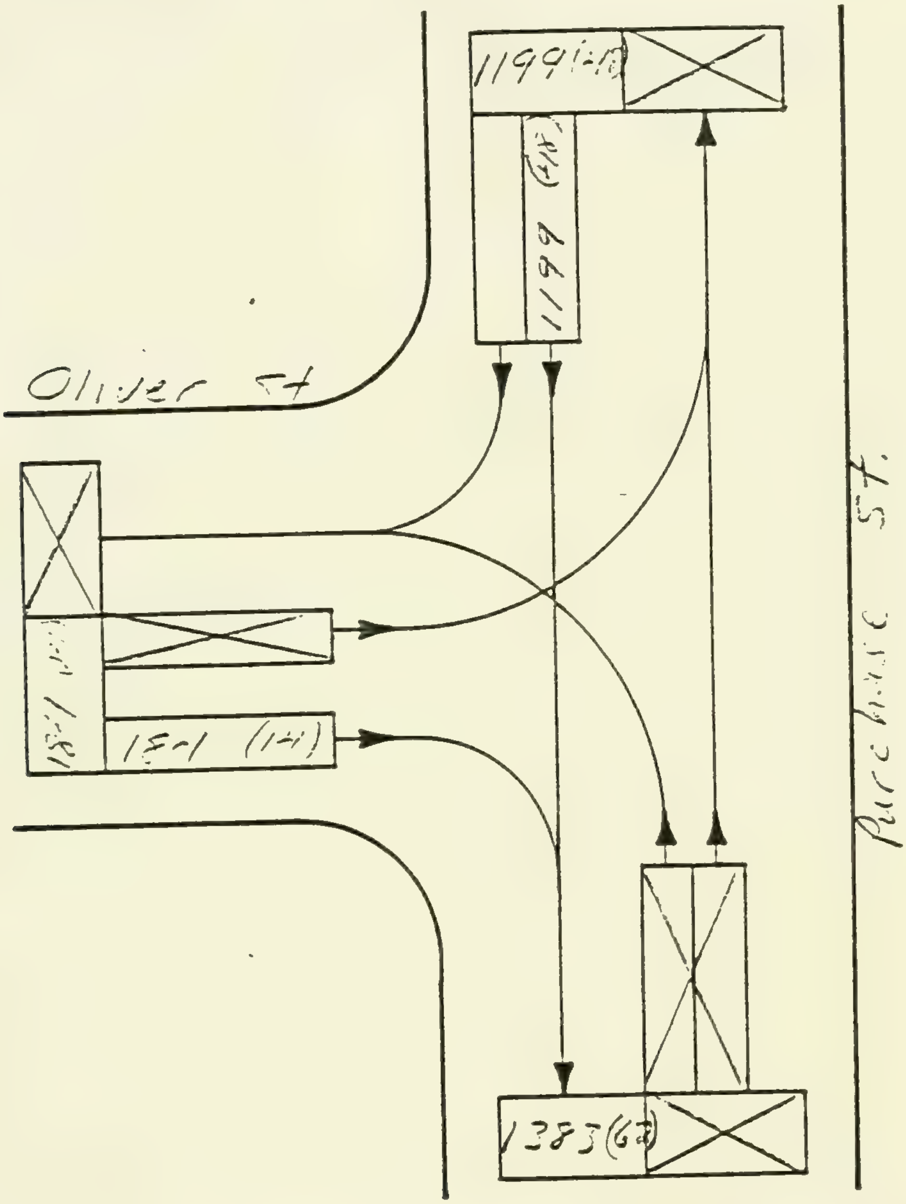
STREET	ENTERING VOLUME	PERCENT OF FLOW	TIME of COUNT
Purchase St	621 (46)	59 %	8:00 to 9:00
Oliver St	429 (22)	41 %	
			AM Peak Hour
			VEHICLES COUNTED
			ALL VEHICLES XXX 1050
			TRUCKS (XX) 68
TOTAL	1050 (68)	100 %	PERCENT TRUCKS 6.5 %

Vanasse/Hangen
Consulting Engineers & Planners
60 Birmingham Parkway, Boston, MA 02135
617/783-7000

INTERSECTION TURNING MOVEMENT COUNT

CITY Boston, MA DATE 9/[illegible] DAY of WEEK Tuesday

INTERSECTION Purchase St / Oliver St JOB No. [illegible]



STREET	ENTERING VOLUME	PERCENT OF FLOW	TIME of COUNT
Purchase St	1199 49	86.7%	4:45 to 5:45
Oliver St	184 14	13.3%	
			PM Peak Hour
			VEHICLES COUNTED
			ALL VEHICLES XXX / 1383
			TRUCKS (XX) 63
TOTAL	1383 (63)	100.0%	PERCENT TRUCKS 4.5 %

STUDY INTERSECTION
LEVEL OF SERVICE ANALYSIS

1602/487/wpr

.985 HCM: SIGNALIZED INTERSECTIONS 1
****
Vanasse / Hangen Associates

SECTION: SUMMER STREET AND HIGH & SOUTH STR
ST: RAR
OF ANALYSIS: AM PEAK
OF ANALYSIS: 09/22/86
TYPE: CBD
INFO: EXISTING CONDITIONS AM1

CAPACITY AND LEVEL OF SERVICE

BY LANE GROUP						BY APPROACH		
CRIT. MVMT.	V/S FLOW RATIO	CAP.	X V/C RATIO	STOPPED DELAY (SEC/VEH)	LOS	APPROACH	STOPPED DELAY (SEC/VEH)	LOS
TR	.08	716	.19	19.4	C	EB	19.4	C
TR *	.11	1687	.27	20.2	C	WB	20.2	C
L	.19	591	.33	8	B			
T *	.21	909	.35	11	B	NB	9.9	B
TR	.12	1392	.2	9.8	B	SB	9.8	B

TERSECTION:	SUM (V/S)c	Xc	DELAY	LOS
	.32	.34	14.2	B

INPUT VOLUMES

MVMT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
LEFT	0	0	174	79
THRU	120	138	238	110
RIGHT	0	241	0	55
R-O-R	0	0	0	0

R-O-R = RIGHT-ON-RED
VOLUMES DO NOT REFLECT GROWTH FACTOR. SEE SECTION F.

1985 HCM: SIGNALIZED INTERSECTIONS
****
Vanasse / Hangen Associates

INTERSECTION: SUMMER STREET AND HIGH & SOUTH ST
ANALYST: RAR
TIME OF ANALYSIS: PM PEAK
DATE OF ANALYSIS: 09/22/86
AREA TYPE: CBD
MISC. INFO: EXISTING CONDITIONS PM1

A) CAPACITY AND LEVEL OF SERVICE

BY LANE GROUP							BY APPROACH		
LANE GROUP	CRIT. MVMT.	V/S FLOW RATIO	CAP.	X V/C RATIO	STOPPED DELAY (SEC/VEH)	LOS	APPROACH	STOPPED DELAY (SEC/VEH)	LOS
EB LTR	*	.29	534	.63	22.1	C	EB	22.1	C
WB LTR		.08	1835	.17	17.4	C	WB	17.4	C
NB L		.05	473	.11	7.8	B			
NB T		.1	774	.18	11	B	NB	10.2	B
SB LTR	*	.13	1491	.24	11.5	B	SB	11.5	B

INTERSECTION:	SUM (V/S)c	Xc	DELAY	LOS
	.41	.43	15.9	C

B) INPUT VOLUMES

MVMT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
LEFT	84	8	42	75
THRU	148	192	126	160
RIGHT	75	66	0	72
R-O-R	0	0	0	0

R-O-R = RIGHT-ON-RED
VOLUMES DO NOT REFLECT GROWTH FACTOR. SEE SECTION F.

****

Vanasse / Hangen Associates

RSECTION: SUMMER STREET AND HIGH & SOUTH STR
YST: RAR
OF ANALYSIS: AM PEAK
OF ANALYSIS: 10/02/86
TYPE: CBD
.INFO: NO BUILD CONDITION 1994 { BUILD CONDITION 1994

CAPACITY AND LEVEL OF SERVICE

	BY LANE GROUP						BY APPROACH		
P	CRIT. MVMT.	V/S FLOW RATIO	CAP.	X .V/C RATIO	STOPPED DELAY (SEC/VEH)	LOS	APPROACH	STOPPED DELAY (SEC/VEH)	LOS
LTR		.08	716	.19	19.4	C	EB	19.4	C
LTR	*	.13	1725	.33	20.7	C	WB	20.7	C
L		.25	582	.42	8.8	B			
T	*	.33	909	.6	14.3	B	NB	12.6	B
L		.13	306	.26	7.7	B			
TR		.15	872	.25	10.2	B	SB	9.4	B

TERSECTION:	SUM (V/S) =	Xc	DELAY	LOS
	.49	.52	15.1	C

INPUT VOLUMES

MVMT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
LEFT	0	0	219	79
THRU	120	212	487	142
RIGHT	0	251	0	55
R-O-R	0	0	0	0

R-O-R = RIGHT-ON-RED
VOLUMES DO NOT REFLECT GROWTH FACTOR. SEE SECTION F.

1985 HCM: SIGNALIZED INTERSECTIONS
****
Vanasse / Hangen Associates

INTERSECTION: SUMMER STREET AND HIGH & SOUTH STR
ANALYST: RAR
TIME OF ANALYSIS: PM PEAK
DATE OF ANALYSIS: 10/02/9[illegible]
AREA TYPE: CBD
MISC.INFO: NO BUILD CONDITION 199[illegible] PM [illegible] { BUILD CONDITION 1994

A) CAPACITY AND LEVEL OF SERVICE

BY LANE GROUP							BY APPROACH		
LANE GROUP	CRIT MVMT.	V/S FLOW RATIO	CAP.	V/C RATIO	STOPPED DELAY (SEC/VEH)	LOS	APPROACH	STOPPED DELAY (SEC/VEH)	LOS
EB LTR		.57	527	1.29	N.A.	F	EB	N.A.	F
WB LTR		.09	1307	.2	17.7	C	WB	17.7	C
NB L		.05	460	.1	7.5	B			
NB T		.11	774	.22	11.4	C	NB	10.6	B
SB LTR		.14	1[illegible]	.29	11.[illegible]	B	SB	11.6	B

[illegible] DELAY [illegible] WHEN [illegible] 1.1

INTERSECTION:	SUM (V/S):	Xc	DELAY	LOS
	.7[illegible]	1.[illegible]	N.A.	[illegible]

B) INPUT VOLUMES

MVMT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
LEFT	17[illegible]	8	43	75
THRU	357	195	160	177
RIGHT	115	56	0	71
RTOR	[illegible]	0	0	0

[illegible]
VOLUMES DO NOT REFLECT GROWTH FACTOR. SEE SECTION [illegible]

1985 HCM:SIGNALIZED INTERSECTIONS ..1

Vanasse / Hangen Associates

SECTION: SUMMER STREET AND SURFACE & PURCHASE STREETS
ST: RAR
OF ANALYSIS: AM PEAK
OF ANALYSIS: 09/22/86
TYPE: CBD
INFO: EXISTING CONDITIONS AM2

CAPACITY AND LEVEL OF SERVICE

	CRIT. MVMT.	V/S FLOW RATIO	CAP.	X V/C RATIO	STOPPED DELAY (SEC/VEH)	LOS	APPROACH	STOPPED DELAY (SEC/VEH)	LOS
		BY LANE GROUP					BY APPROACH		
T	*	.05	887	.27	35.6	D	EB	35.6	D
L	*	.17	1077	.45	17.9	C			
T		.12	561	.32	22.7	C	WB	19.2	C
R		.11	4008	.11	0	A	NB	0	A
L	*	.24	1219	.56	16.7	C			
TR		.2	1060	.45	21	C	SB	18.5	C

TERSECTION:	SUM (V/S)c	Xc	DELAY	LOS
	.46	.51	17.2	C

INPUT VOLUMES

MVMT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
LEFT	0	418	0	585
THRU	199	164	0	198
RIGHT	0	0	349	215
R-O-R	0	0	0	0

R-O-R = RIGHT-ON-RED
VOLUMES DO NOT REFLECT GROWTH FACTOR. SEE SECTION F.

1985 HCM: SIGNALIZED INTERSECTIONS
****
Vanasse / Hangen Associates

INTERSECTION: SUMMER STREET AND SURFACE & PURCHASE STREETS
ANALYST: RAR
TIME OF ANALYSIS: PM PEAK
DATE OF ANALYSIS: 09/11/8_
AREA TYPE: CBD
MISC.INFO: EXISTING CONDITIONS PM2

A) CAPACITY AND LEVEL OF SERVICE

BY LANE GROUP								BY APPROACH		
LANE GROUP		CRIT. MVMT.	V/S FLOW RATIO	CAP.	X V/C RATIO	STOPPED DELAY (SEC/VEH)	LOS	APPROACH	STOPPED DELAY (SEC/VEH)	LOS
EB	T	*	.06	887	.31	35.8	D	EB	35.8	D
WB	L	*	.18	1360	.38	12.7	B			
WB	T		.14	708	.28	16.1	C	WB	13.6	B
NB	R		.06	4008	.06	0	A	NB	0	A
SB	L	*	.17	483	.53	21.6	C			
SB	LTR		.15	1433	.46	27.4	D	SB	25.8	D

INTERSECTION:	SUM (V/S)c	Xc	DELAY	LOS
	.42	.46	20.3	C

B) INPUT VOLUMES

MVMT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
LEFT	0	448	0	230
THRU	223	180	0	458
RIGHT	0	0	185	86
R-O-R	0	0	0	0

R-O-R = RIGHT-ON-RED
VOLUMES DO NOT REFLECT GROWTH FACTOR. SEE SECTION F.

****

Vanasse / Hangen Associates

TERSECTION: SUMMER STREET AND [illegible]

ALYST: RAR

[illegible] OF ANALYSIS: AM PEAK

[illegible] OF ANALYSIS: 10/02/8[illegible]

[illegible] TYPE: CBD

[illegible].INFO: NO BUILD CONDITION 19-4 [illegible] { BUILD CONDITION 1994

CAPACITY AND LEVEL OF SERVICE

	BY LANE GROUP						BY APPROACH		
[illegible]P	CRIT. MVMT.	V/S FLOW RATIO	CAP.	X V/C RATIO	STOPPED DELAY (SEC/VEH)	LOS	APPROACH	STOPPED DELAY (SEC/VEH)	LOS
T	*	.05	887	.07	35.6	D	EB	35.6	D
L	*	.19	1077	.49	18.2	C			
T		.14	561	.37	23.2	C	WB	19.7	C
R		.[illegible]	400[illegible]	.[illegible]	[illegible]	A	NB	0	A
L		.24	1219	.75	16.7	C			
TR	*	.[illegible]	1094	.67	22.[illegible]	C	SB	19.8	C

INTERSECTION:	SUM (V/S)c	Xc	DELAY	LOS
	.[illegible]	.50	18.9	C

INPUT VOLUMES

MVMT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
LEFT	0	45[illegible]	0	585
THRU	197	187	0	357
RIGHT	0	0	249	276
R-T-R	0	0	0	0

[illegible] R = RIGHT-TURN-RED

VOLUMES DO NOT REFLECT GROWTH FACTOR. SEE SECTION F.

1985 HCM: SIGNALIZED INTERSECTIONS

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Vanasse / Hangen Associates

INTERSECTION: SUMMER STREET AND SURFACE & PURCHA
ANALYST: RAR
TIME OF ANALYSIS: PM PEAK
DATE OF ANALYSIS: 10/02/86
AREA TYPE: CBD
MISC. INFO: NO BUILD CONDITION 1994 PMONE & BUILD CONDITION 1994

A) CAPACITY AND LEVEL OF SERVICE

BY LANE GROUP								BY APPROACH		
LANE GROUP		CRIT. MVMT.	V/S FLOW RATIO	CAP.	X V/C RATIO	STOPPED DELAY (SEC/VEH)	LOS	APPROACH	STOPPED DELAY (SEC/VEH)	LOS
EB	T	*	.1[illegible]	887	.53	30	D	EB	30	[illegible]
WB	L	*	.21	1360	.40	13.1	B			
WB	T		.14	708	.08	16.[illegible]	C	WB	13.8	[illegible]
NB	R		.15	4008	.15	0	A	NB	0	[illegible]
SB	L	*	.17	483	.30	21.6	D			
SB	LTR		.15	1400	.47	27.0	D	SB	25.9	[illegible]

INTERSECTION:	SUM (V/S)c	Xc	DELAY	LOS
	.43	.53	17.1	C

B) INPUT VOLUMES

MVMT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
LEFT	0	478	0	230
THRU	381	130	0	461
RIGHT	0	0	476	59
R-O-R	0	[illegible]	[illegible]	0

R-O-R = RIGHT-ON-RED
VOLUMES [illegible]

****

Vanasse / Hangen Associates

NTERSECTION: SUMMER STREET AND ATLANTIC AVENUE
NALYST: RAR
IME OF ANALYSIS: AM PEAK
ATE OF ANALYSIS: 09/22/86
REA TYPE: CBD
ISC.INFO: EXISTING CONDITIONS AM3

) CAPACITY AND LEVEL OF SERVICE

BY LANE GROUP							BY APPROACH		
ANE ROUP	CRIT. MVMT.	V/S FLOW RATIO	CAP.	X V/C RATIO	STOPPED DELAY (SEC/VEH)	LOS	APPROACH	STOPPED DELAY (SEC/VEH)	LOS
B L	*	.2	366	.8	34.7	D			
B TR		.33	1509	.67	15.6	C	EB	19.9	C
B TR	*	.2	1165	.51	18	C	WB	18	C
B LTR	*	.36	1439	.99	39.6	D	NB	39.6	D

NTERSECTION:	SUM (V/S)c	Xc	DELAY	LOS
	.75	.83	27.9	D

) INPUT VOLUMES

MVMT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
LEFT	263	0	191	0
THRU	870	391	405	0
RIGHT	0	119	565	0
R-O-R	0	0	0	0

R-O-R = RIGHT-ON-RED
VOLUMES DO NOT REFLECT GROWTH FACTOR. SEE SECTION F.

1985 HCM: SIGNALIZED INTERSECTIONS
****
Vanasse / Hangen Associates

INTERSECTION: SUMMER STREET AND ATLANTIC AVENUE
ANALYST: RAR
TIME OF ANALYSIS: PM PEAK
DATE OF ANALYSIS: 09/22/86
AREA TYPE: CBD
MISC.INFO: EXISTING CONDITIONS PM3

A) CAPACITY AND LEVEL OF SERVICE

		BY LANE GROUP					BY APPROACH		
LANE GROUP	CRIT. MVMT.	V/S FLOW RATIO	CAP.	X V/C RATIO	STOPPED DELAY (SEC/VEH)	LOS	APPROACH	STOPPED DELAY (SEC/VEH)	LO
EB L	*	.2	463	.61	23.5	C			
EB TR		.14	1725	.26	15.9	C	EB	18.9	C
WB TR	*	.29	1153	.73	32.3	D	WB	32.3	D
NB LTR	*	.33	1261	1.12	N.A.	F	NB	N.A.	F

NOTE: DELAY MEANINGLESS WHEN X > 1.2

INTERSECTION:	SUM (V/S)c	Xc	DELAY	LOS
	.81	.89	N.A.	F

B) INPUT VOLUMES

MVMT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
LEFT	257	0	100	0
THRU	381	528	807	0
RIGHT	0	198	252	0
R-O-R	0	0	0	0

R-O-R = RIGHT-ON-RED
VOLUMES DO NOT REFLECT GROWTH FACTOR. SEE SECTION F.

1985 HCM: SIGNALIZED INTERSECTIONS

Vanasse / Hangen Associates

NTERSECTION: SUMMER STREET AND ATLANTIC AVENUE
NALYST: RAR
IME OF ANALYSIS: AM PEAK
ATE OF ANALYSIS: 10/02/86
REA TYPE: CBD
ISC.INFO: NO BUILD CONDITION 1994 AM3NB & BUILD CONDITION 1994

) CAPACITY AND LEVEL OF SERVICE

LANE GROUP		CRIT. MVMT.	V/S FLOW RATIO	CAP.	X V/C RATIO	STOPPED DELAY (SEC/VEH)	LOS	APPROACH	STOPPED DELAY (SEC/VEH)	LOS
B	L	*	.2	366	.8	34.7	D			
B	TR		.29	1509	.6	14.4	B	EB	19.4	C
B	TR	*	.27	1141	.68	20.5	C	WB	20.5	C
B	LTR	*	.33	1470	.91	29.5	D	NB	29.5	D

BY LANE GROUP (first eight columns); BY APPROACH (last three columns)

NTERSECTION:	SUM (V/S)c	Xc	DELAY	LOS
	.79	.87	23.8	C

) INPUT VOLUMES

MVMT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
LEFT	263	0	191	0
THRU	770	449	490	0
RIGHT	0	219	415	0
R-O-R	0	0	0	0

R-O-R = RIGHT-ON-RED
VOLUMES DO NOT REFLECT GROWTH FACTOR. SEE SECTION F.

1985 HCM: SIGNALIZED INTERSECTIONS

****

Vanasse / Hangen Associates

INTERSECTION: SUMMER STREET AND ATLANTIC AVENUE
ANALYST: RAR
TIME OF ANALYSIS: PM PEAK
DATE OF ANALYSIS: 10/02/86
AREA TYPE: CBD
MISC.INFO: NO BUILD CONDITION 1994 PMCNB & BUILD CONDITION 1994

A) CAPACITY AND LEVEL OF SERVICE

BY LANE GROUP							BY APPROACH		
LANE GROUP	CRIT. MVMT.	V/S FLOW RATIO	CAP.	X V/C RATIO	STOPPED DELAY (SEC/VEH)	LOS	APPROACH	STOPPED DELAY (SEC/VEH)	LOS
EB L	*	.38	468	1.2	N.A.	F			
EB TR		.22	1725	.39	17.6	C	EB	N.A.	F
WB TR	*	.33	1141	.84	35.5	D	WB	35.5	D
NB LTR	*	.23	1209	.78	40.7	E	NB	40.7	E

NOTE: DELAY MEANINGLESS WHEN X > 1.2

INTERSECTION:	SUM (V/S)c	Xc	DELAY	LOS
	.94	1.03		E

B) INPUT VOLUMES

MVMT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
LEFT	507	0	100	0
THRU	581	528	421	0
RIGHT	0	298	252	0
R-O-R	0	0	0	0

R-O-R = RIGHT-ON-RED
VOLUMES DO NOT REFLECT GROWTH FACTOR. SEE SECTION F.

****

Vanasse / Hangen Associates

ERSECTION: FEDERAL STREET AND HIGH STREET
LYST: RAR
E OF ANALYSIS: AM PEAK
E OF ANALYSIS: 07/22/86
A TYPE: CBD
.INFO: EXISTING CONDITIONS AM4

CAPACITY AND LEVEL OF SERVICE

E UP	CRIT. MVMT.	V/S FLOW RATIO	CAP.	X V/C RATIO	STOPPED DELAY (SEC/VEH)	LOS	APPROACH	STOPPED DELAY (SEC/VEH)	LOS
BY LANE GROUP							BY APPROACH		
T	*	.25	1473	.51	13.9	B	WB	13.9	B
TR		.11	1361	.21	9.8	B	SB	10.4	B
R	*	.2	544	.39	11.2	B	SB	10.4	B

ERSECTION:	SUM (V/S)c	Xc	DELAY	LOS
	.44	.47	12.5	B

INPUT VOLUMES

MVMT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
LEFT	0	0	0	0
THRU	0	649	0	244
RIGHT	0	0	0	197
R-O-R	0	0	0	0

R-O-R = RIGHT-ON-RED
VOLUMES DO NOT REFLECT GROWTH FACTOR. SEE SECTION F.

1985 HCM:SIGNALIZED INTERSECTIONS
****
Vanasse / Hangen Associates

INTERSECTION: FEDERAL STREET AND HIGH STREET
ANALYST: RAR
TIME OF ANALYSIS: PM PEAK
DATE OF ANALYSIS: 09/22/86
AREA TYPE: CBD
MISC.INFO: EXISTING CONDITIONS PM4

A) CAPACITY AND LEVEL OF SERVICE

BY LANE GROUP							BY APPROACH		
LANE GROUP	CRIT MVMT.	V/S FLOW RATIO	CAP.	X V/C RATIO	STOPPED DELAY (SEC/VEH)	LOS	APPROACH	STOPPED DELAY (SEC/VEH)	LOS
WB T	*	.1	1386	.20	12.9	B	WB	12.9	B
SB TR	*	.14	1440	.25	8.9	B	SB	8.8	B
SB R		.09	576	.16	8.4	B	SB	8.8	B

INTERSECTION:	SUM (V/S)c	Xc	DELAY	LOS
	.24	.26	10.5	B

B) INPUT VOLUMES

MVMT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
LEFT	0	0	0	0
THRU	0	276	0	307
RIGHT	0	0	0	81
R-O-R	0	0	0	0

R-O-R = RIGHT-ON-RED
VOLUMES DO NOT REFLECT GROWTH FACTOR. SEE SECTION F.

1985 HCM: SIGNALIZED INTERSECTIONS
****
Vanasse / Hangen Associates

ERSECTION: FEDERAL STREET AND HIGH STREET
LYST: RAR
E OF ANALYSIS: AM PEAK
E OF ANALYSIS: 10/02/94
A TYPE: CBD
O.INFO: NO BUILD CONDITION 1994 AM4NB & BUILD CONDITION 1994

CAPACITY AND LEVEL OF SERVICE

BY LANE GROUP							BY APPROACH		
E GP	CRIT. MVMT.	V/S FLOW RATIO	CAP	X V/C RATIO	STOPPED DELAY (SEC/VEH)	LOS	APPROACH	STOPPED DELAY (SEC/VEH)	LOS
T	*	.33	1478	.68	16.1	C	WB	16.1	C
TR		.12	1361	.24	10	B	SB	11	B
R	*	.25	544	.48	12.2	B	SB	11	B

TERSECTION:	SUM (V/S)=	X=	DELAY	LOS
	.58	.61	14.2	B

INPUT VOLUMES

MMT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
LEFT	0	0	0	0
THRU	0	958	0	276
RIGHT	0	0	0	237
R-O-R	0	0	0	0

R-O-R = RIGHT-ON-RED
VOLUMES DO NOT REFLECT GROWTH FACTOR. SEE SECTION F.

1985 HCM: SIGNALIZED INTERSECTIONS
****
Vanasse / Hangen Associates

INTERSECTION: [illegible] STREET AND [illegible] STREET
ANALYST: RAF
TIME OF ANALYSIS: PM PEAK
DATE OF ANALYSIS: 10/02/86
AREA TYPE: CBD
MISC.INFO: NO BUILD CONDITION 1994 PHASE & BUILD CONDITION 1994

A) CAPACITY AND LEVEL OF SERVICE

		BY LANE GROUP						BY APPROACH		
LANE GROUP	CRIT. MVMT.	V/S FLOW RATIO	CAP	X V/C RATIO	STOPPED DELAY (SEC/VEH)	LOS		APPROACH	STOPPED DELAY (SEC/VEH)	LOS
WB	T	*	.13	1326	.28	13.2	B	WB	13.2	B
SB	TR	*	.14	1440	.24	9	B	SB	8.9	B
SB	R		.11	576	.17	8.6	B	SB	8.9	B

INTERSECTION:	SUM (V/S)c	Xc	DELAY	LOS
	.27	.29	10.8	B

B) INPUT VOLUMES

MVMT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
LEFT	0	0	0	0
THRU	0	330	0	324
RIGHT	0	0	0	101
R-O-R	0	0	0	0

R-O-R = RIGHT-ON-RED
VOLUMES DO NOT REFLECT GROWTH FACTOR. SEE SECTION F.

****

Vanasse / Hangen Associates

TRSECTION: CONGRESS AND FRANKLIN
AYST: RAR
M OF ANALYSIS: AM PEAK
T OF ANALYSIS: 09/22/86
E TYPE: CBD
S.INFO: EXISTING CONDITIONS AMS

: CAPACITY AND LEVEL OF SERVICE

BY LANE GROUP							BY APPROACH		
P.	CRIT. MVMT.	V/S FLOW RATIO	CAP.	X V/C RATIO	STOPPED DELAY (SEC/VEH)	LOS	APPROACH	STOPPED DELAY (SEC/VEH)	LOS
TR	*	.2	1487	.43	9.9	B	EB	9.9	B
LT	*	.14	672	.58	18.7	C	SB	18.7	C

TERSECTION:	SUM (V/S)c	Xc	DELAY	LOS
	.34	.37	13.2	B

INPUT VOLUMES

MVMT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
LEFT	0	0	0	102
THRU	443	0	0	232
RIGHT	103	0	0	0
R-O-R	0	0	0	0

R-O-R = RIGHT-ON-RED
VOLUMES DO NOT REFLECT GROWTH FACTOR. SEE SECTION F.

1985 HCM: SIGNALIZED INTERSECTIONS

Vanasse / Hangen Associates

INTERSECTION: CONGRESS AND FRANKLIN
ANALYST: RAR
TIME OF ANALYSIS: PM PEAK
DATE OF ANALYSIS: 09/22/85
AREA TYPE: CBD
MISC.INFO: EXISTING CONDITIONS PM3

A) CAPACITY AND LEVEL OF SERVICE

BY LANE GROUP								BY APPROACH		
LANE GROUP		CRIT. MVMT.	V/S FLOW RATIO	CAP.	X V/C RATIO	STOPPED DELAY (SEC/VEH)	LOS	APPROACH	STOPPED DELAY (SEC/VEH)	LOS
EB	TR	*	.36	1549	.79	14.3	B	EB	14.3	B
SB	L		.07	378	.3	16.6	C			
SB	T	*	.12	302	.43	18.2	C	SB	17.5	C

INTERSECTION:	SUM (V/S)c	Xc	DELAY	LOS
	.48	.52	14.8	B

B) INPUT VOLUMES

MVMT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
LEFT	0	0	0	109
THRU	966	0	0	139
RIGHT	142	0	0	0
R-O-R	0	0	0	0

R-O-R = RIGHT-ON-RED
VOLUMES DO NOT REFLECT GROWTH FACTOR. SEE SECTION F.

1985 HCM: SIGNALIZED INTERSECTIONS
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Vanasse / Hangen Associates

TRSECTION: CONGRESS AND FRANKLIN
AYST: RAR
Y OF ANALYSIS: [illegible] PM
T OF ANALYSIS: 10/02/8[illegible]
C TYPE: CBD
E.INFO NO BUILD CONDITION 1994 AMPEAK { NO BUILD CONDITION

CAPACITY AND LEVEL OF SERVICE

	BY LANE GROUP						BY APPROACH		
GP	CRIT. MVMT.	V/C FLOW RATIO	CAP.	X V/C RATIO	STOPPED DELAY (SEC/VEH)	LOS	APPROACH	STOPPED DELAY (SEC/VEH)	LOS
TR	*	.3	1516	.65	11.8	B	EB	11.8	B
LT	*	.14	472	.32	18.7	C	SB	18.7	C

INTERSECTION:	SUM (V/S)c	Xc	DELAY	LOS
	.44	.48	13.8	B

INPUT VOLUMES

MVM	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
LEFT	0	0	0	102
THRU	741	0	0	232
RIGHT	103	0	0	0
R-O-R	0	0	0	0

R-O-R = RIGHT-ON-RED
VOLUMES DO NOT REFLECT GROWTH FACTOR. SEE SECTION F.

1983 HCM: SIGNALIZED INTERSECTIONS

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Vanasse / Hangen Associates

INTERSECTION: CONGRESS AND FRANKLIN
ANALYST: RAH
TIME OF ANALYSIS: PM PEAK
DATE OF ANALYSIS: 10/01/84
AREA TYPE: CBD
MISC. INFO: NO BUILD CONDITION 1994 PMENB & NO BUILD CONDITION

A) CAPACITY AND LEVEL OF SERVICE

BY LANE GROUP								BY APPROACH		
LANE GROUP		CRIT. MVMT.	V/S FLOW RATIO	CAP.	X V/C RATIO	STOPPED DELAY (SEC/VEH)	LOS	APPROACH	STOPPED DELAY (SEC/VEH)	LOS
EB	TR	*	.48	1381	1.05	47.8	E	EB	47.8	E
SB	L		.11	378	.44	17.6	C			
SB	T	*	.11	302	.40	13.2	C	SB	17.9	C

INTERSECTION:	SUM (V/S) c	Xc	DELAY	LOS
	.6	.65	43.1	E

B) INPUT VOLUMES

MVMT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
LEFT	0	0	0	159
THRU	1366	0	0	138
RIGHT	141	0	0	0
R-O-R	0	0	0	0

R-O-R = RIGHT-ON-RED
VOLUMES DO NOT REFLECT GROWTH FACTOR. SEE SECTION F.

1985 HCM:SIGNALIZED INTERSECTIONS 21 1
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Vanasse / Hangen Associates

NTRSECTION: CONGRESS STREET AND HIGH STREET
NAYST: RAR
IM OF ANALYSIS: AM PEAK
AT OF ANALYSIS: 09/22/86
RE TYPE: CBD
IS.INFO: EXISTING CONDITIONS AM6

CAPACITY AND LEVEL OF SERVICE

AN RCP	CRIT. MVMT.	V/S FLOW RATIO	CAP.	X V/C RATIO	STOPPED DELAY (SEC/VEH)	LOS	APPROACH	STOPPED DELAY (SEC/VEH)	LOS
		BY LANE GROUP					BY APPROACH		
B TR	*	.12	3195	.21	6.2	B	EB	6.2	B
B L		.21	516	.65	19.5	C			
B T	*	.3	413	.91	37	D	SB	28.3	D

ITERSECTION:	SUM (V/S)c	Xc	DELAY	LOS
	.42	.45	17.9	C

INPUT VOLUMES

MVMT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
LEFT	0	0	0	301
THRU	440	0	0	339
RIGHT	105	0	0	0
R-O-R	0	0	0	0

R-O-R = RIGHT-ON-RED
VOLUMES DO NOT REFLECT GROWTH FACTOR. SEE SECTION F.

1985 HCM: SIGNALIZED INTERSECTIONS

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Vanasse / Hangen Associates

INTERSECTION: CONGRESS STREET AND HIGH STREE
ANALYST: RAR
TIME OF ANALYSIS: PM PEAK
DATE OF ANALYSIS: 09/22/86
AREA TYPE: CBD
MISC.INFO: EXISTING CONDITIONS PM6

A) CAPACITY AND LEVEL OF SERVICE

BY LANE GROUP							BY APPROACH		
LANE GROUP	CRIT. MVMT.	V/S FLOW RATIO	CAP.	X V/C RATIO	STOPPED DELAY (SEC/VEH)	LOS	APPROACH	STOPPED DELAY (SEC/VEH)	LOS
EB TR	*	.23	3261	.4	7.2	B	EB	7.2	B
SB L		.15	516	.47	16.9	C			
SB T	*	.23	413	.69	21.3	C	SB	19.3	C

INTERSECTION:	SUM (V/S)c	Xc	DELAY	LOS
	.46	.49	10.7	B

D) INPUT VOLUMES

MVMT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
LEFT	0	0	0	219
THRU	945	0	0	233
RIGHT	130	0	0	0
R-O-R	0	0	0	0

R-O-R = RIGHT-ON-RED
VOLUMES DO NOT REFLECT GROWTH FACTOR. SEE SECTION F.

1985 HCM: SIGNALIZED INTERSECTIONS
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Vanasse / Hangen Associates

ERSECTION: CONGRESS STREET AND HIGH STREET
LYST: RAP
E OF ANALYSIS: ...
E OF ANALYSIS: 10/14 ...
A TYPE: CBD
C. INFO: NO BUILD CONDITION 1994 AM&NB

CAPACITY AND LEVEL OF SERVICE

		BY LANE GROUP					BY APPROACH		
LANE GROUP	CRIT. MVMT.	V/S FLOW RATIO	CAP.	X V/C RATIO	STOPPED DELAY (SEC/VEH)	LOS	APPROACH	STOPPED DELAY (SEC/VEH)	LOS
TR	*	.19	3175	.32	6.8	B	EB	6.8	B
L		.44	516	1.4	N.A.	F			
T	*	.51	413	1.37	N.A.	F	SB	N.A.	F

E: DELAY MEANINGLESS WHEN X > 1.2

INTERSECTION:	SUM (V/S)c	Xc	DELAY	LOS
	.7	.75	N.A.	F

INPUT VOLUMES

MVMT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
LEFT	0	0	0	651
THRU	687	0	0	585
RIGHT	156	0	0	0
R-O-R	0	0	0	0

R-O-R = RIGHT-ON-RED
VOLUMES DO NOT REFLECT GROWTH FACTOR. SEE SECTION F.

1985 HCM: SIGNALIZED INTERSECTIONS
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Vanasse / Hangen Associates

INTERSECTION: CONGRESS STREET AND HIGH STREET
[illegible] RAP
[illegible]
TIME OF ANALYSIS: [illegible]
AREA TYPE: CBD
MISC.INFO: NO BUILD CONDITION 1994 PMANE & BUILD CONDITION 1994

A) CAPACITY AND LEVEL OF SERVICE

LANE GROUP		CRIT. MVMT.	V/S FLOW RATIO	CAP.	X V/C RATIO	STOPPED DELAY (SEC/VEH)	LOS	APPROACH	STOPPED DELAY (SEC/VEH)	LOS
EB	TR	*	.37	3008	.54	9	B	EB	9	B
SB	L	*	.57	516	1.76	N.A.	F			
SB	T		.23	413	.7	21.3	C	SB	N.A.	F

(BY LANE GROUP: columns LANE GROUP through LOS; BY APPROACH: columns APPROACH through LOS)

* NOTE: DELAY MEANINGLESS WHEN X > 1.2

INTERSECTION:	SUM (V/S)c	Xc	DELAY	LOS
	.94	1.02	N.A.	F

B) INPUT VOLUMES

MVMT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
LEFT	0	0	0	519
THRU	1576	0	0	260
RIGHT	167	0	0	0
R-O-R	0	0	0	0

R-O-R - RIGHT-ON-RED
VOLUMES DO NOT REFLECT GROWTH FACTOR. SEE SECTION F.

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Vanasse / Hangen Associates .

INTERSECTION: CONGRESS STREET AND HIGH STREET
ANALYST: RAR
TIME OF ANALYSIS: AM PEAK
DATE OF ANALYSIS: 10/14/86
AREA TYPE: CBD
ADD.INFO: BUILD CONDITION AM6894

CAPACITY AND LEVEL OF SERVICE

		BY LANE GROUP						BY APPROACH		
LANE GROUP	CRIT. MVMT.	V/S FLOW RATIO	CAP.	X V/C RATIO	STOPPED DELAY (SEC/VEH)	LOS	APPROACH	STOPPED DELAY (SEC/VEH)	LOS
EB TR	*	.19	3193	.32	6.8	B	EB	6.8	B
SB L	.	.46	516	1.4	N.A.	F			
SB T	*	.51	413	1.57	N.A.	F	SB	N.A.	F

NOTE: DELAY MEANINGLESS WHEN X > 1.2

INTERSECTION:	SUM (V/S)c	Xc	DELAY	LOS
	.7	.75	N.A.	F

INPUT VOLUMES

MVMT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
LEFT	0	0	0	631
THRU	687	0	0	585
RIGHT	156	0	0	0
R-O-R	0	0	0	0

R-O-R = RIGHT-ON-RED
VOLUMES DO NOT REFLECT GROWTH FACTOR. SEE SECTION F.

1985 HCM:SIGNALIZED INTERSECTIONS

Vanasse / Hangen Associates

INTERSECTION: CONGRESS STREET AND PURCHASE STREET
ANALYST: RAR
TIME OF ANALYSIS: AM PEAK
DATE OF ANALYSIS: 09/22/86
AREA TYPE: CBD
MISC.INFO: EXISTING CONDITIONS AM7

A) CAPACITY AND LEVEL OF SERVICE

BY LANE GROUP								BY APPROACH		
LANE GROUP		CRIT. MVMT.	V/S FLOW RATIO	CAP.	X V/C RATIO	STOPPED DELAY (SEC/VEH)	LOS	APPROACH	STOPPED DELAY (SEC/VEH)	LOS
EB	TR	*	.16	2017	.45	16.5	C	EB	16.5	C
SB	L	*	.37	1991	.58	7.6	B			
SB	T		.17	579	.37	12.4	B	SB	8.3	B

INTERSECTION:	SUM (V/S)c	Xc	DELAY	LOS
	.53	.59	11.6	B

B) INPUT VOLUMES

MVMT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
LEFT	0	0	0	990
THRU	548	0	0	192
RIGHT	193	0	0	0
R-O-R	0	0	0	0

R-O-R = RIGHT-ON-RED
VOLUMES DO NOT REFLECT GROWTH FACTOR. SEE SECTION F.

1985 HCM: SIGNALIZED INTERSECTIONS

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Vanasse / Hangen Associates

ITERSECTION: CONGRESS STREET AND PURCHASE STREET
ALYST: RAR
IME OF ANALYSIS: PM PEAK
ITE OF ANALYSIS: 09/22/86
EA TYPE: CBD
SC.INFO: EXISTING CONDITIONS PM7

) CAPACITY AND LEVEL OF SERVICE

	BY LANE GROUP							BY APPROACH		
NE OUP		CRIT. MVMT.	V/S FLOW RATIO	CAP.	X V/C RATIO	STOPPED DELAY (SEC/VEH)	LOS	APPROACH	STOPPED DELAY (SEC/VEH)	LOS
	TR	*	.27	2227	.64	19.6	C	EB	19.6	C
	L	*	.46	918	.8	15.1	C			
	LT		.28	1119	.71	22.8	C	SB	19.1	C

NTERSECTION:	SUM (V/S)c	Xc	DELAY	LOS
	.73	.82	19.3	C

) INPUT VOLUMES

MVMT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
LEFT	0	0	0	664
THRU	672	0	0	680
RIGHT	492	0	0	0
R-O-R	0	0	0	0

R-O-R = RIGHT-ON-RED
VOLUMES DO NOT REFLECT GROWTH FACTOR. SEE SECTION F.

1985 HCM:SIGNALIZED INTERSECTIONS

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Vanasse / Hangen Associates

INTERSECTION: CONGRESS STREET AND PURCHASE STREET
ANALYST: RAR
TIME OF ANALYSIS: AM PEAK
DATE OF ANALYSIS: 10/14/86
AREA TYPE: CBD
MISC.INFO: NO BUILD CONDITION 1994 AM7NB

A) CAPACITY AND LEVEL OF SERVICE

BY LANE GROUP								BY APPROACH		
LANE GROUP		CRIT. MVMT.	V/S FLOW RATIO	CAP.	X V/C RATIO	STOPPED DELAY (SEC/VEH)	LOS	APPROACH	STOPPED DELAY (SEC/VEH)	LOS
EB	TR	*	.29	2060	.79	20.9	C	EB	20.9	C
SB	L	*	.59	1991	.93	17.5	C			
SB	T		.12	579	.27	11.6	B	SB	17	C

INTERSECTION:	SUM (V/S)c	Xc	DELAY	LOS
	.88	.98	18.8	C

B) INPUT VOLUMES

MVMT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
LEFT	0	0	0	1589
THRU	1095	0	0	142
RIGHT	243	0	0	0
R-O-R	0	0	0	0

R-O-R = RIGHT-ON-RED
VOLUMES DO NOT REFLECT GROWTH FACTOR. SEE SECTION F.

1985 HCM:SIGNALIZED INTERSECTIONS

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Vanasse / Hangen Associates

ITERSECTION: CONGRESS STREET AND PURCHASE STREET
AALYST: RAR
TME OF ANALYSIS: PM PEAK
DTE OF ANALYSIS: 10/14/86
AEA TYPE: CBD
MSC.INFO: NO BUILD CONDITION 1994 PM7NB

) CAPACITY AND LEVEL OF SERVICE

BY LANE GROUP							BY APPROACH		
LNE GOUP	CRIT. MVMT.	V/S FLOW RATIO	CAP.	X V/C RATIO	STOPPED DELAY (SEC/VEH)	LOS	APPROACH	STOPPED DELAY (SEC/VEH)	LOS
E TR	*	.57	2227	1.35	N.A.	F	EB	N.A.	F
S L	*	.55	918	.96	28.3	D			
S LT		.45	1119	1.13	N.A.	F	SB	N.A.	F

NTE: DELAY MEANINGLESS WHEN X > 1.2

NTERSECTION:	SUM (V/S)c	Xc	DELAY	LOS
	1.12	1.25	N.A.	F

) INPUT VOLUMES

MVMT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
LEFT	0	0	0	790
THRU	1470	0	0	1084
RIGHT	988	0	0	0
R-O-R	0	0	0	0

R-O-R = RIGHT-ON-RED
VOLUMES DO NOT REFLECT GROWTH FACTOR. SEE SECTION F.

1985 HCM: SIGNALIZED INTERSECTIONS

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Vanasse / Hangen Associates

INTERSECTION: CONGRESS STREET AND PURCHASE STREET
ANALYST: RAR
TIME OF ANALYSIS: AM PEAK
DATE OF ANALYSIS: 10/14/86
AREA TYPE: CBD
MISC.INFO: BUILD CONDITION 1994 AM7B94

A) CAPACITY AND LEVEL OF SERVICE

BY LANE GROUP								BY APPROACH		
LANE GROUP		CRIT. MVMT.	V/S FLOW RATIO	CAP.	X V/C RATIO	STOPPED DELAY (SEC/VEH)	LOS	APPROACH	STOPPED DELAY (SEC/VEH)	LO
EB	TR	*	.29	2060	.79	20.9	C	EB	20.9	C
SB	L	*	.59	1991	.93	17.8	C			
SB	T		.13	579	.29	11.8	B	SB	17.3	C

INTERSECTION:	SUM (V/S)c	Xc	DELAY	LOS
	.88	.98	18.9	C

B) INPUT VOLUMES

MVMT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
LEFT	0	0	0	1594
THRU	1095	0	0	152
RIGHT	243	0	0	0
R-O-R	0	0	0	0

R-O-R = RIGHT-ON-RED
VOLUMES DO NOT REFLECT GROWTH FACTOR. SEE SECTION F.

1985 HCM: SIGNALIZED INTERSECTIONS

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Vanasse / Hangen Associates

ITERSECTION: CONGRESS STREET AND PURCHASE STREET
AALYST: RAR
TME OF ANALYSIS: PM PEAK
DTE OF ANALYSIS: 10/14/86
AEA TYPE: CBD
MSC.INFO: BUILD CONDITION 1994 PM7B94

) CAPACITY AND LEVEL OF SERVICE

BY LANE GROUP							BY APPROACH		
LNE GOUP	CRIT. MVMT.	V/S FLOW RATIO	CAP.	X V/C RATIO	STOPPED DELAY (SEC/VEH)	LOS	APPROACH	STOPPED DELAY (SEC/VEH)	LOS
E TR	*	.57	2227	1.35	N.A.	F	EB	N.A.	F
S L	*	.67	918	1.17	N.A.	F			
S LT		.62	1119	1.54	N.A.	F	SB	N.A.	F

TE: DELAY MEANINGLESS WHEN X > 1.2

NTERSECTION:	SUM (V/S)c	Xc	DELAY	LOS
	1.24	1.38	N.A.	F

) INPUT VOLUMES

MVMT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
LEFT	0	0	0	964
THRU	1470	0	0	1476
RIGHT	988	0	0	0
R-O-R	0	0	0	0

R-O-R = RIGHT-ON-RED
VOLUMES DO NOT REFLECT GROWTH FACTOR. SEE SECTION F.

1985 HCM: SIGNALIZED INTERSECTIONS

Vanasse / Hangen Associates

INTERSECTION: CONGRESS STREET AND PURCHASE STREET
ANALYST: RAR
TIME OF ANALYSIS: PM PEAK
DATE OF ANALYSIS: 10/14/86
AREA TYPE: CBD
MISC.INFO: MITIGATION MEASURES FOR THE 1994 BUILD CONDITION PM7B94M

ADDITION OF LANE SB ON PURCHASE

A) CAPACITY AND LEVEL OF SERVICE

BY LANE GROUP								BY APPROACH		
LANE GROUP		CRIT. MVMT.	V/S FLOW RATIO	CAP.	X V/C RATIO	STOPPED DELAY (SEC/VEH)	LOS	APPROACH	STOPPED DELAY (SEC/VEH)	LOS
EB	TR	*	.57	2227	1.35	N.A.	F	EB	N.A.	F
SB	L	*	.67	918	1.17	N.A.	F			
SB	LT		.42	1719	1.05	N.A.	F	SB	N.A.	F

NOTE: DELAY MEANINGLESS WHEN X > 1.2

INTERSECTION:	SUM (V/S)c	Xc	DELAY	LOS
	1.24	1.38	N.A.	F

B) INPUT VOLUMES

MVMT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
LEFT	0	0	0	964
THRU	1470	0	0	1476
RIGHT	988	0	0	0
R-O-R	0	0	0	0

R-O-R = RIGHT-ON-RED
VOLUMES DO NOT REFLECT GROWTH FACTOR. SEE SECTION F.

1985 HCM: SIGNALIZED INTERSECTIONS

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Vanasse / Hangen Associates

:ITERSECTION: CONGRESS STREET AND ATLANTIC AVENUE
/IALYST: RAR
:ME OF ANALYSIS: AM PEAK
ITE OF ANALYSIS: 09/29/86
/EA TYPE: CBD
:SC.INFO: EXISTING CONDITIONS AM8

) CAPACITY AND LEVEL OF SERVICE

		BY LANE GROUP						BY APPROACH		
NE OUP	CRIT. MVMT.	V/S FLOW RATIO	CAP.	X V/C RATIO	STOPPED DELAY (SEC/VEH)	LOS		APPROACH	STOPPED DELAY (SEC/VEH)	LOS
L	*	.25	1170	.65	18	C				
T		.32	2339	.44	4.7	A		EB	10.4	B
TR	*	.3	906	.9	31.1	D		WB	31.1	D
L		.18	423	.65	24.3	C				
TR	*	.21	847	.74	30.4	D		NB	28.5	D

NTERSECTION:	SUM (V/S)c	Xc	DELAY	LOS
	.76	.84	19.8	C

) INPUT VOLUMES

MVMT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
LEFT	654	0	248	0
THRU	884	347	391	0
RIGHT	0	348	148	0
R-O-R	0	0	0	0

R-O-R = RIGHT-ON-RED
VOLUMES DO NOT REFLECT GROWTH FACTOR. SEE SECTION F.

1985 HCM:SIGNALIZED INTERSECTIONS

Vanasse / Hangen Associates

INTERSECTION: CONGRESS STREET AND ATLANTIC AVENUE
ANALYST: RAR
TIME OF ANALYSIS: PM PEAK
DATE OF ANALYSIS: 09/22/86
AREA TYPE: CBD
MISC.INFO: EXISTING CONDITIONS PM8

A) CAPACITY AND LEVEL OF SERVICE

BY LANE GROUP								BY APPROACH		
LANE GROUP		CRIT. MVMT.	V/S FLOW RATIO	CAP.	X V/C RATIO	STOPPED DELAY (SEC/VEH)	LOS	APPROACH	STOPPED DELAY (SEC/VEH)	LOS
EB	L	*	.26	1170	.66	18.2	C			
EB	T		.24	2339	.34	5.2	B	EB	11.7	B
WB	TR	*	.27	915	.82	28	D	WB	28	D
NB	L		.27	437	.98	52.2	E			
NB	TR	*	.33	873	1.17	N.A.	F	NB	N.A.	F

NOTE: DELAY MEANINGLESS WHEN X > 1.2

INTERSECTION:	SUM (V/S)c	Xc	DELAY	LOS
	.86	.95	N.A.	F

B) INPUT VOLUMES

MVMT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
LEFT	663	0	384	0
THRU	673	357	792	0
RIGHT	0	283	86	0
R-O-R	0	0	0	0

R-O-R = RIGHT-ON-RED
VOLUMES DO NOT REFLECT GROWTH FACTOR. SEE SECTION F.

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Vanasse / Hangen Associates

II'ERSECTION: CONGRESS STREET AND ATLANTIC AVENUE
A LYST: RAR
T'IE OF ANALYSIS: AM PEAK
D'E OF ANALYSIS: 10/02/86
A A TYPE: CBD
M SC.INFO: NO BUILD CONDITION AM8NB

) CAPACITY AND LEVEL OF SERVICE

		BY LANE GROUP						BY APPROACH		
L NE G OUP		CRIT. MVMT.	V/S FLOW RATIO	CAP.	X V/C RATIO	STOPPED DELAY (SEC/VEH)	LOS	APPROACH	STOPPED DELAY (SEC/VEH)	LOS
E	L	*	.61	1170	1.56	N.A.	F			
E	T		.44	2339	.61	5.4	B	EB	N.A.	F
	TR	*	.39	896	1.17	N.A.	F	WB	N.A.	F
	LTR	*	.26	1271	.93	39.4	D	NB	39.4	D

TE: DELAY MEANINGLESS WHEN X > 1.2

NTERSECTION:	SUM (V/S)c	Xc	DELAY	LOS
	1.26	1.4	N.A.	F

) INPUT VOLUMES

MVMT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
LEFT	1566	0	248	0
THRU	1223	347	576	0
RIGHT	0	548	148	0
R-O-R	0	0	0	0

R-O-R = RIGHT-ON-RED
VOLUMES DO NOT REFLECT GROWTH FACTOR. SEE SECTION F.

1985 HCM:SIGNALIZED INTERSECTIONS

****

Vanasse / Hangen Associates

INTERSECTION: CONGRESS STREET AND ATLANTIC AVENUE
ANALYST: RAR
TIME OF ANALYSIS: PM PEAK
DATE OF ANALYSIS: 10/02/86
AREA TYPE: CBD
MISC.INFO: NO BUILD CONDITION 1994 PM9NB

A) CAPACITY AND LEVEL OF SERVICE

BY LANE GROUP								BY APPROACH		
LANE GROUP		CRIT. MVMT.	V/S FLOW RATIO	CAP.	X V/C RATIO	STOPPED DELAY (SEC/VEH)	LOS	APPROACH	STOPPED DELAY (SEC/VEH)	LOS
EB	L	*	.4	1170	1.02	47	E			
EB	T		.46	2339	.63	6.3	B	EB	24.5	C
WB	TR	*	.27	915	.82	28	D	WB	28	D
NB	L	*	.43	419	1.55	N.A.	F			
NB	TR		.25	838	.89	45.1	E	NB	N.A.	F

NOTE: DELAY MEANINGLESS WHEN X > 1.2

INTERSECTION:	SUM (V/S)c	Xc	DELAY	LOS
	1.1	1.22	N.A.	F

B) INPUT VOLUMES

MVMT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
LEFT	1025	0	585	0
THRU	1272	357	406	0
RIGHT	0	293	235	0
R-O-R	0	0	0	0

R-O-R = RIGHT-ON-RED
VOLUMES DO NOT REFLECT GROWTH FACTOR. SEE SECTION F.

1985 HCM:SIGNALIZED INTERSECTIONS

****

Vanasse / Hangen Associates

NERSECTION: CONGRESS STREET AND ATLANTIC AVENUE
NLYST: RAR
IE OF ANALYSIS: AM PEAK
AE OF ANALYSIS: 10/10/86
RA TYPE: CBD
IC.INFO: BUILD CONDITION 1994 AMBB94

A) CAPACITY AND LEVEL OF SERVICE

		BY LANE GROUP					BY APPROACH		
E UP	CRIT. MVMT.	V/S FLOW RATIO	CAP.	X V/C RATIO	STOPPED DELAY (SEC/VEH)	LOS	APPROACH	STOPPED DELAY (SEC/VEH)	LOS
L	*	.61	1170	1.56	N.A.	F			
T		.44	2339	.61	5.4	B	EB	N.A.	F
TR	*	.39	896	1.17	N.A.	F	WB	N.A.	F
LTR	*	.26	1271	.93	39.4	D	NB	39.4	D

TE: DELAY MEANINGLESS WHEN X > 1.2

NTERSECTION:	SUM (V/S)c	Xc	DELAY	LOS
	1.26	1.4	N.A.	F

) INPUT VOLUMES

MVMT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
LEFT	1570	0	248	0
THRU	1224	347	576	0
RIGHT	0	548	148	0
R-O-R	0	0	0	0

R-O-R = RIGHT-ON-RED
VOLUMES DO NOT REFLECT GROWTH FACTOR. SEE SECTION F.

1985 HCM: SIGNALIZED INTERSECTIONS

Vanasse / Hangen Associates

INTERSECTION: CONGRESS STREET AND ATLANTIC AVENUE
ANALYST: RAR
TIME OF ANALYSIS: PM PEAK
DATE OF ANALYSIS: 10/10/86
AREA TYPE: CBD
MISC.INFO: BUILD CONDITION 1994 PMSB94

A) CAPACITY AND LEVEL OF SERVICE

LANE GROUP		CRIT. MVMT.	V/S FLOW RATIO	CAP.	X V/C RATIO	STOPPED DELAY (SEC/VEH)	LOS	APPROACH	STOPPED DELAY (SEC/VEH)	LOS
BY LANE GROUP								BY APPROACH		
EB	L	*	.45	1170	1.16	N.A.	F			
EB	T		.47	2339	.65	6.5	B	EB	55.8	E
WB	TR	*	.27	915	.82	28	D	WB	28	D
NB	L	*	.43	419	1.55	N.A.	F			
NB	TR		.25	838	.89	45.1	E	NB	N.A.	F

NOTE: DELAY MEANINGLESS WHEN X > 1.2

INTERSECTION:	SUM (V/S)c	Xc	DELAY	LOS
	1.16	1.28	N.A.	F

B) INPUT VOLUMES

MVMT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
LEFT	1168	0	585	0
THRU	1303	357	406	0
RIGHT	0	283	235	0
R-O-R	0	0	0	0

R-O-R = RIGHT-ON-RED
VOLUMES DO NOT REFLECT GROWTH FACTOR. SEE SECTION F.

1985 HCM: SIGNALIZED INTERSECTIONS

Vanasse / Hangen Associates

RSECTION: CONGRESS STREET AND ATLANTIC AVENUE
YST: RAR
OF ANALYSIS: AM PEAK
OF ANALYSIS: 10/27/86
TYPE: CBD
.INFO: MITIGATION MEASURES FOR THE 1994 BUILD CONDITION AM8B94M

ADDITION OF WB LANE ON CONGRESS - REMOVE PARKING
ADDITION OF NB LANE ATLANTIC - REMOVE PARKING OR INH PEAK HOUR RESTRICT

CAPACITY AND LEVEL OF SERVICE

BY LANE GROUP							BY APPROACH		
E JP	CRIT. MVMT.	V/S FLOW RATIO	CAP.	X V/C RATIO	STOPPED DELAY (SEC/VEH)	LOS	APPROACH	STOPPED DELAY (SEC/VEH)	LOS
L	*	.61	1170	1.56	N.A.	F			
T		.44	2339	.61	5.4	B	EB	N.A.	F
TR	*	.14	984	.41	21	C	WB	N.A.	F
R		.49	418	1.46	N.A.	F	WB	N.A.	F
L		.18	428	.64	24.1	C			
TR	*	.19	1271	.7	28.4	D	NB	27.4	D

E: DELAY MEANINGLESS WHEN X > 1.2

ITERSECTION:	SUM (V/S)c	Xc	DELAY	LOS
	.94	1.04	N.A.	F

INPUT VOLUMES

MVMT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
LEFT	1570	0	248	0
THRU	1224	347	576	0
RIGHT	0	548	148	0
R-O-R	0	0	0	0

R-O-R = RIGHT-ON-RED
VOLUMES DO NOT REFLECT GROWTH FACTOR. SEE SECTION F.

1985 HCM: SIGNALIZED INTERSECTIONS

Vanasse / Hangen Associates

INTERSECTION: CONGRESS STREET AND ATLANTIC AVENUE
ANALYST: RAR
TIME OF ANALYSIS: PM PEAK
DATE OF ANALYSIS: 10/27/86
AREA TYPE: CBD
MISC.INFO: MITIGATION MEASURES FOR THE 1994 BUILD Condition - PM8894M

ADDITION OF WB & NB LANE WITH REMOVAL OF PARKING - IMPOSE PEAK HOUR RESTRICTIONS

A) CAPACITY AND LEVEL OF SERVICE

BY LANE GROUP								BY APPROACH		
LANE GROUP		CRIT. MVMT.	V/S FLOW RATIO	CAP.	X V/C RATIO	STOPPED DELAY (SEC/VEH)	LOS	APPROACH	STOPPED DELAY (SEC/VEH)	LOS
EB	L	*	.45	1170	1.16	N.A.	F			
EB	T		.47	2339	.65	6.5	B	EB	55.8	E
WB	TR	*	.14	984	.42	26.5	D	WB	28.2	D
WB	R		.25	418	.75	30.5	D	WB	28.2	D
NB	L	*	.43	419	1.55	N.A.	F			
NB	TR		.17	1244	.63	33.5	D	NB	N.A.	F

NOTE: DELAY MEANINGLESS WHEN X > 1.2

INTERSECTION:	SUM (V/S)c	Xc	DELAY	LOS
	1.03	1.14	N.A.	F

B) INPUT VOLUMES

MVMT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
LEFT	1168	0	585	0
THRU	1303	357	406	0
RIGHT	0	283	235	0
R-O-R	0	0	0	0

R-O-R = RIGHT-ON-RED
VOLUMES DO NOT REFLECT GROWTH FACTOR. SEE SECTION F.

.985 HCM: SIGNALIZED INTERSECTIONS
****
Vanasse / Hangen Associates

SECTION: PEARL STREET AND HIGH STREET
ST: RAR
OF ANALYSIS: AM PEAK
OF ANALYSIS: 09/22/86
TYPE: CBD
INFO: EXISTING CONDITIONS AM9

CAPACITY AND LEVEL OF SERVICE

	CRIT. MVMT.	V/S FLOW RATIO	CAP.	X V/C RATIO	STOPPED DELAY (SEC/VEH)	LOS	APPROACH	STOPPED DELAY (SEC/VEH)	LOS
	BY LANE GROUP						BY APPROACH		
L		.01	412	.05	16.7	C			
T	*	.02	330	.06	16.8	C	WB	16.8	C
TR	*	.36	1418	.66	10.5	B	SB	10.5	B

TERSECTION:	SUM (V/S)c	Xc	DELAY	LOS
	.38	.41	10.8	B

INPUT VOLUMES

MVMT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
LEFT	0	18	0	0
THRU	0	20	0	622
RIGHT	0	0	0	219
R-O-R	0	0	0	0

R-O-R = RIGHT-ON-RED
VOLUMES DO NOT REFLECT GROWTH FACTOR. SEE SECTION F.

1985 HCM:SIGNALIZED INTERSECTIONS

Vanasse / Hangen Associates

INTERSECTION: PEARL STREET AND HIGH STREET
ANALYST: RAR
TIME OF ANALYSIS: PM PEAK
DATE OF ANALYSIS: 09/22/86
AREA TYPE: CBD
MISC.INFO: EXISTING CONDITIONS PMS

A) CAPACITY AND LEVEL OF SERVICE

BY LANE GROUP							BY APPROACH		
LANE GROUP	CRIT. MVMT.	V/S FLOW RATIO	CAP.	X V/C RATIO	STOPPED DELAY (SEC/VEH)	LOS	APPROACH	STOPPED DELAY (SEC/VEH)	LOS
WB L		.01	417	.05	16.7	C			
WB T	*	.02	333	.07	16.9	C	WB	16.8	C
SB TR	*	.23	1477	.42	8.1	B	SB	8.1	B

INTERSECTION:	SUM (V/S)c	Xc	DELAY	LOS
	.25	.27	8.7	B

B) INPUT VOLUMES

MVMT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
LEFT	0	17	0	0
THRU	0	22	0	460
RIGHT	0	0	0	71
R-O-R	0	0	0	0

R-O-R = RIGHT-ON-RED
VOLUMES DO NOT REFLECT GROWTH FACTOR. SEE SECTION F.

1985 HCM: SIGNALIZED INTERSECTIONS
****

Vanasse / Hangen Associates

RSECTION: PEARL STREET AND HIGH STREET
YST: RAR
OF ANALYSIS: AM PEAK
T OF ANALYSIS: 10/19/8L
E TYPE: CBD
.INFO: NO BUILD CONDITION 1994 AM9ND

CAPACITY AND LEVEL OF SERVICE

	BY LANE GROUP						BY APPROACH		
LANE GROUP	CRIT. MVMT.	V/S FLOW RATIO	CAP.	X V/C RATIO	STOPPED DELAY (SEC/VEH)	LOS	APPROACH	STOPPED DELAY (SEC/VEH)	LOS
L	*	.32	412	1.22	N.A.	F			
T		.23	330	.86	34.9	D	WB	N.A.	F
TR	*	.36	1477	.65	10.3	B	SB	10.3	B

: DELAY MEANINGLESS WHEN X > 1.2

INTERSECTION:	SUM (V/S)c	Xc	DELAY	LOS
	.48	.73		E

INPUT VOLUMES

MVMT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
LEFT	0	472	0	0
THRU	0	266	0	764
RIGHT	0	0	0	94
R-O-R	0	0	0	0

R-O-R = RIGHT-ON-RED
VOLUMES DO NOT REFLECT GROWTH FACTOR. SEE SECTION F.

1985 HCM: SIGNALIZED INTERSECTIONS

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Vanasse / Hangen Associates

INTERSECTION [illegible] STREET AND HIGH STREET
ANALYST [illegible]
TIME OF ANALYSIS [illegible]
DATE OF ANALYSIS. [illegible]/14/[illegible]
AREA TYPE. CBD
MISC.INFO. NO BUILD CONDITION 1994 PM[illegible]

A) CAPACITY AND LEVEL OF SERVICE

			BY LANE GROUP					BY APPROACH		
LANE GROUP		CRIT. MVMT.	V/S FLOW RATIO	CAP.	X V/C RATIO	STOPPED DELAY (SEC/VEH)	LOS	APPROACH	STOPPED DELAY (SEC/VEH)	LOS
WB	L	*	.13	417	.49	19.7	C			
WB	T		.12	[illegible]	.47	19.6	C	WB	19.7	C
SB	TR	*	.4	1509	.73	11.5	B	SB	11.5	B

INTERSECTION:	SUM (V/S)c	Xc	DELAY	LOS
	.53	.57	11.5	B

B) INPUT VOLUMES

MVMT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
LEFT	0	184	0	0
THRU	0	140	0	894
RIGHT	0	0	0	46
R-O-R	0	0	0	0

R-O-R = RIGHT-ON-RED
VOLUMES DO NOT REFLECT GROWTH FACTOR. SEE SECTION F.

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1985 HCM: SIGNALIZED INTERSECTIONS
****
Vanasse / Hangen Associates

SECTION: PEARL STREET AND HIGH STREET
. RAF
OF ANALYSIS: AM PEAK
OF ANALYSIS: 10/14/86
TYPE: CBD
INFO: BUILD CONDITION 1994 AM9494

CAPACITY AND LEVEL OF SERVICE

		BY LANE GROUP					BY APPROACH		
P	CRIT. MVMT.	V/S FLOW RATIO	CAP.	X V/C RATIO	STOPPED DELAY (SEC/VEH)	LOS	APPROACH	STOPPED DELAY (SEC/VEH)	LOS
L	*	.32	412	1.22	N.A.	F			
T		.23	330	.66	35.5	D	WB	N.A.	F
TR	*	.31	1477	.60	10.3	B	SB	10.3	B

: DELAY MEANINGLESS WHEN X > 1.2

TERSECTION:	SUM (V/S)c	Xc	DELAY	LOS
	.63	.73		E

INPUT VOLUMES

MVMT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
LEFT	0	472	0	0
THRU	0	258	0	764
RIGHT	0	0	0	94
R-O-R	0	0	0	0

R-O-R = RIGHT-ON-RED
VOLUMES DO NOT REFLECT GROWTH FACTOR. SEE SECTION F.

1985 HCM: SIGNALIZED INTERSECTIONS

Vanasse / Hangen Associates

INTERSECTION: [illegible] STREET AND [illegible] STREET
ANALYST: [illegible]
TIME OF ANALYSIS: [illegible]
DATE OF ANALYSIS: 1/14/8[illegible]
AREA TYPE: CBD
MISC.INFO: BUILD CONDITION 1994 PM7894

A) CAPACITY AND LEVEL OF SERVICE

LANE GROUP	CRIT. MVMT.	V/S FLOW RATIO	CAP.	X V/C RATIO	STOPPED DELAY (SEC/VEH)	LOS	APPROACH	STOPPED DELAY (SEC/VEH)	LOS
WB L		[illegible]	417	.49	19.7	C			
WB T	*	.1[illegible]	[illegible]	.65	23.1	C	WB	21.5	C
SB TR	*	.4[illegible]	[illegible]	.7[illegible]	11.[illegible]	B	SB	11.5	B

INTERSECTION:	SUM (V/S)c	XC	DELAY	LOS
	.57	.62	14.3	B

B) INPUT VOLUMES

MVT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
LEFT	0	184	0	0
THRU	0	196	0	894
RIGHT	0	0	0	46
R-O-R	0	0	0	0

R-O-R = RIGHT-ON-RED
VOLUMES DO NOT REFLECT GROWTH FACTOR. SEE SECTION F.

:'85 HCM: UNSIGNALIZED INTERSECTIONS
****
Vanasse / Hangen Associates

47

:SECTION NAME: OLIVER/FRANKLIN
.ST: RAR
: OF ANALYSIS: AM PEAK
: OF ANALYSIS: 09/22/86
: INFO: EXISTING CONDITIONS AM11

INPUT VOLUMES

JLL HOUR VOLUMES (vph)

OVEMENT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
LEFT	0	197	0	0
THRU	0	201	0	212
RIGHT	10	0	0	58

GEOMETRY

	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
OF LANES	1	2	2	1
% GRADE	0	0	0	0
RT ANGLE	90	90	90	90
ANE 1 USE			LEFT	
ANE 2 USE			THRU/RIGHT	

ADJUSTMENT FACTORS

EHICLE COMPOSITION

	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
% MC'S	0	0	0	0
SU/RV'S	0	0	0	0
% CV'S	0	7.5	0	3

VERAGE RUNNING SPEED ON MAJOR ROAD (mph): 25
REA POPULATION: 1000000
ONTROL ON NB APPROACH: STOP SIGN
ONTROL ON SB APPROACH: STOP SIGN
EAK HOUR FACTOR: .88

D) CRITICAL GAP ADJUSTMENT TABLE 46

			TABULAR VALUES	ADJUSTED BY	ACTUAL VALUES
MINOR	NB				
		LT	6	-.5	5.5
		TH	5.5	-.5	5
		RT	5	-.5	4.5
MINOR	SB				
		LT	6.5	-.5	6
		TH	6	-.5	5.5
		RT	5	-.5	4.5
MAJOR	EB				
		LT	4.5	-.5	4
MAJOR	WB				
		LT	4.5	-.5	4

E) LEVEL OF SERVICE RESULTS

MOVEMENT AND LANE USAGE		VOLUME	MOV'T CAPACITY	SHARED CAPACITY	RESERVE CAPACITY	LOS
MINOR SB	SHARED LANE	278	N.A.	588	310	B
MAJOR WB	LEFTS	212	1000	N.A.	788	A

1985 HCM: UNSIGNALIZED INTERSECTIONS

****

Vanasse / Hangen Associates

ECTION NAME:
T: RAR
F ANALYSIS: PM PEAK
F ANALYSIS: 09/22/86
NFO: EXISTING CONDITIONS PM11

47

INPUT VOLUMES

LL HOUR VOLUMES (vph)

VEMENT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
LEFT	0	73	0	0
THRU	0	134	0	210
IGHT	18	0	0	51

GEOMETRY

	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
OF LANES	1	2	2	1
% GRADE	0	0	0	0
RT ANGLE	90	90	90	90
NE 1 USE			LEFT	
NE 2 USE			THRU/RIGHT	

ADJUSTMENT FACTORS

EHICLE COMPOSITION

	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
% MC'S	0	0	0	0
SU/RV'S	0	0	0	0
% CV'S	0	2	0	1

VERAGE RUNNING SPEED ON MAJOR ROAD (mph): 25
REA POPULATION: 1000000
ONTROL ON NB APPROACH: STOP SIGN
ONTROL ON SB APPROACH: STOP SIGN
EAK HOUR FACTOR: .95

D) CRITICAL GAP ADJUSTMENT TABLE

			TABULAR VALUES	ADJUSTED BY	ACTUAL VALUES
MINOR	NB				
		LT	6	-.5	5.5
		TH	5.5	-.5	5
		RT	5	-.5	4.5
MINOR	SB				
		LT	6.5	-.5	6
		TH	6	-.5	5.5
		RT	5	-.5	4.5
MAJOR	EB				
		LT	4.5	-.5	4
MAJOR	WB				
		LT	4.5	-.5	4

E) LEVEL OF SERVICE RESULTS

MOVEMENT AND LANE USAGE		VOLUME	MOV'T CAPACITY	SHARED CAPACITY	RESERVE CAPACITY	LOS
MINOR SB	SHARED LANE	264	N.A.	781	517	A
MAJOR WB	LEFTS	74	1000	N.A.	926	A

****
Vanasse / Hangen Associates

ERSECTION NAME: OLIVER & FRANKLIN
LYST: RAR
E OF ANALYSIS: AM PEAK
E OF ANALYSIS: 10/09/86
.INFO: NO BUILD CONDITION 1994 AM11NB & BUILD CONDITION 1994

INPUT VOLUMES

ULL HOUR VOLUMES (vph)

OVEMENT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
LEFT	0	138	0	0
THRU	0	139	0	212
RIGHT	10	0	0	58

GEOMETRY

	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
OF LANES	1	2	2	1
% GRADE	0	0	0	0
RT ANGLE	90	90	90	90
ANE 1 USE			LEFT	
ANE 2 USE			THRU/RIGHT	

ADJUSTMENT FACTORS

EHICLE COMPOSITION

	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
% MC'S	0	0	0	0
SU/RV'S	0	0	0	0
% CV'S	0	7.5	0	3

VERAGE RUNNING SPEED ON MAJOR ROAD (mph): 25
REA POPULATION: 1000000
ONTROL ON NB APPROACH: STOP SIGN
ONTROL ON SB APPROACH: STOP SIGN
EAK HOUR FACTOR: .88

D) CRITICAL GAP ADJUSTMENT TABLE

			TABULAR VALUES	ADJUSTED BY	ACTUAL VALUES
MINOR	NB				
		LT	6	-.5	5.5
		TH	5.5	-.5	5
		RT	5	-.5	4.5
MINOR	SB				
		LT	6.5	-.5	6
		TH	6	-.5	5.5
		RT	5	-.5	4.5
MAJOR	SB				
		LT	4.5	-.5	4
MAJOR	WB				
		LT	4.5	-.5	4

E) LEVEL OF SERVICE RESULTS

MOVEMENT AND LANE USAGE		VOLUME	MOV'T CAPACITY	SHARED CAPACITY	RESERVE CAPACITY	LOS
MINOR SB	SHARED LANE	278	N.A.	699	421	A
MAJOR WB	LEFTS	140	1001	N.A.	802	A

****

Vanasse / Hangen Associates

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RSECTION NAME: OLIVER & FRANKLIN
T: RAR
F ANALYSIS: PM PEAK
F ANALYSIS: 10/05/93
NFO: NO BUILD CONDITION 1994 PM1 NB { BUILD CONDITION 1994

INPUT VOLUMES

PEAK HOUR VOLUMES (vph)
****

MOVEMENT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
********	**********	**********	**********	**********
LEFT	0	66	0	0
THRU	0	120	0	235
RIGHT	43	0	0	51

GEOMETRY

	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
	**********	**********	**********	**********
# OF LANES	1	2	2	1
% GRADE	0	0	0	0
RT ANGLE	90	90	90	90
LANE 1 USE			LEFT	
LANE 2 USE			THRU/RIGHT	

ADJUSTMENT FACTORS

VEHICLE COMPOSITION
****

	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
	**********	**********	**********	**********
[illegible]				
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2	[illegible]	1

AVERAGE RUNNING SPEED ON MAJOR ROAD (mph): 27
AREA POPULATION: 100000
CONTROL ON NB APPROACH: STOP SIGN
CONTROL ON SB APPROACH: STOP SIGN
PEAK HOUR FACTOR: .95

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1) CRITICAL GAP ADJUSTMENT TABLE

			TABULAR VALUES	ADJUSTED BY	ACTUAL VALUES
MINOR	NB				
		LT	6	-.5	5.5
		TH	5.5	-.5	5
		RT	5	-.5	4.5
MINOR	SB				
		LT	6.5	-.5	6
		TH	6	-.5	5.5
		RT	5	-.5	4.5
MAJOR	EB				
		LT	4.5	-.5	4
MAJOR	WB				
		LT	4.5	-.5	4

2) LEVEL OF SERVICE RESULTS

MOVEMENT AND LANE USAGE		VOLUME	MOV'T CAPACITY	SHARED CAPACITY	RESERVE CAPACITY	LOS
MINOR SB	SHARED LANE	289	N.A.	781	492	A
MAJOR WB	LEFTS	57	[illegible]	N.A.	[illegible]	A

1985 HCM: UNSIGNALIZED INTERSECTIONS
****
Vanasse / Hangen Associates

55

TERSECTION NAME: OLIVER & HIGH
ALST: RAR
ME OF ANALYSIS: AM PEAK
TE OF ANALYSIS: 09/24/86
SC INFO: EXISTING CONDITIONS AM12

INPUT VOLUMES

FULL HOUR VOLUMES (vph)

MOVEMENT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
LEFT	0	0	0	0
THRU	0	601	0	382
RIGHT	0	0	0	0

GEOMETRY

	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
# OF LANES	2	2	2	2
% GRADE	0	-1	0	0
RT ANGLE	90	90	90	90
LANE 1 USE			LEFT	LEFT/THRU
LANE 2 USE			THRU/RIGHT	THRU/RIGHT

ADJUSTMENT FACTORS

VEHICLE COMPOSITION: UNKNOWN
AVERAGE RUNNING SPEED ON MAJOR ROAD (mph): 25
AREA POPULATION: 1000000
CONTROL ON NB APPROACH: YIELD SIGN
CONTROL ON SB APPROACH: STOP SIGN
PEAK HOUR FACTOR: .9

1985 HCM: UNSIGNALIZED INTERSECTIONS
****

> CRITICAL GAP ADJUSTMENT TABLE

			TABULAR VALUES	ADJUSTED BY	ACTUAL VALUES
MINOR	NB				
		LT	6	-.5	5.5
		TH	5.5	-.5	5
		RT	4.5	-.5	4
MINOR	SB				
		LT	6.5	-.5	6
		TH	6	-.5	5.5
		RT	5	-.5	4.5
MAJOR	EB				
		LT	5	-.5	4.5
MAJOR	WB				
		LT	5	-.5	4.5

> LEVEL OF SERVICE RESULTS

MOVEMENT AND LANE USAGE	VOLUME	MOV'T CAPACITY	SHARED CAPACITY	RESERVE CAPACITY	LOS
MINOR SB SHARED LANE	420	N.A.	469	259	C

85 HCM:UNSIGNALIZED INTERSECTIONS
****
Vanasse / Hangen Associates 57

SECTION NAME: OLIVER & HIGH
ST: RAR
OF ANALYSIS: PM PEAK
OF ANALYSIS: 09/24/96
INFO: EXISTING CONDITIONS PM12

INPUT VOLUMES

LL HOUR VOLUMES (vph)
****

OVEMENT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
*******	**********	**********	**********	**********
LEFT	0	0	0	0
THRU	0	213	0	361
RIGHT	0	0	0	0

GEOMETRY

	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
	**********	**********	**********	**********
OF LANES	2	2	2	2
% GRADE	0	-1	0	0
RT ANGLE	90	90	90	90
LANE 1 USE			LEFT	LEFT/THRU
LANE 2 USE			THRU/RIGHT	THRU/RIGHT

ADJUSTMENT FACTORS

VEHICLE COMPOSITION: UNKNOWN
AVERAGE RUNNING SPEED ON MAJOR ROAD (mph): 25
AREA POPULATION: 1000000
CONTROL ON NB APPROACH: YIELD SIGN
CONTROL ON SB APPROACH: STOP SIGN
PEAK HOUR FACTOR: .9

50

D) CRITICAL GAP ADJUSTMENT TABLE

			TABULAR VALUES	ADJUSTED BY	ACTUAL VALUES
MINOR	NB				
		LT	6	-.5	5.5
		TH	5.5	-.5	5
		RT	4.5	-.5	4
MINOR	SB				
		LT	6.5	-.5	6
		TH	6	-.5	5.5
		RT	5	-.5	4.5
MAJOR	EB				
		LT	5	-.5	4.5
MAJOR	WB				
		LT	5	-.5	4.5

E) LEVEL OF SERVICE RESULTS

MOVEMENT AND LANE USAGE	VOLUME	MOV'T CAPACITY	SHARED CAPACITY	RESERVE CAPACITY	LOS
MINOR SB SHARED LANE	397	N.A.	790	592	A

****
Vanasse / Hangen Associates

57

SECTION NAME: PURCHASE & OLIVER
ST: RAR
OF ANALYSIS: AM PEAK
OF ANALYSIS: 09/22/86
INFO: EXISTING CONDITIONS AM13

INPUT VOLUMES

ULL HOUR VOLUMES (vph)
****

OVEMENT	NORTHBOUND	SOUTHBOUND	MINOR (EB)
LEFT	0	0	0
THRU	691	0	0
RIGHT	0	0	526

GEOMETRY

	NORTHBOUND	SOUTHBOUND	MINOR (EB)
OF LANES	2	2	1
% GRADE	0	0	0
RT TURN	90	90	90

ADJUSTMENT FACTORS

EHICLE COMPOSITION
****

	NORTHBOUND	SOUTHBOUND	MINOR (EB)
% MC'S	0	0	0
SU/RV'S	0	0	0
% CV'S	7	0	5

VERAGE RUNNING SPEED ON MAJOR ROAD (mph): 25
REA POPULATION: 1000000
ONTROL ON EB APPROACH: YIELD SIGN
EAK HOUR FACTOR: .93

****

D) CRITICAL GAP ADJUSTMENT TABLE

			TABULAR VALUES	ADJUSTED BY	ACTUAL VALUES
MINOR	EB				
		LT	6	-.5	5.5
		RT	4.5	-.5	4
MAJOR	NB				
		LT	5	-.5	4.5

E) LEVEL OF SERVICE RESULTS

MOVEMENT AND LANE USAGE	VOLUME	MOV'T CAPACITY	SHARED CAPACITY	RESERVE CAPACITY	LOS
MINOR EB SHARED LANE	552	N.A.	957	405	A

CRITICAL GAP ADJUSTMENT TABLE

6L

			TABULAR VALUES	ADJUSTED BY	ACTUAL VALUES
MINOR	EB				
		LT	6	-.5	5.5
		RT	4.5	-.5	4
MAJOR	NB				
		LT	5	-.5	4.5

LEVEL OF SERVICE RESULTS

MOVEMENT AND LANE USAGE	VOLUME	MOV'T CAPACITY	SHARED CAPACITY	RESERVE CAPACITY	LOS
MINOR EB SHARED LANE	199	N.A.	733	534	A

1985 HCM: UNSIGNALIZED INTERSECTIONS
****
Vanasse / Hangen Associates

TERSECTION NAME: PURCHASE & OLIVER
ALYST: RAR
ME OF ANALYSIS: PM PEAK
TE OF ANALYSIS: 09/22/86
SC.INFO: EXISTING CONDITIONS PM13

> INPUT VOLUMES

FULL HOUR VOLUMES (vph)
****

MOVEMENT	NORTHBOUND	SOUTHBOUND	MINOR (EB)
LEFT	0	0	0
THRU	1199	0	0
RIGHT	0	0	184

> GEOMETRY

	NORTHBOUND	SOUTHBOUND	MINOR (EB)
# OF LANES	2	2	1
% GRADE	0	0	0
RT TURN	90	90	90

> ADJUSTMENT FACTORS

VEHICLE COMPOSITION
****

	NORTHBOUND	SOUTHBOUND	MINOR (EB)
% MC'S	0	0	0
% SU/RV'S	0	0	0
% CV'S	4	0	8

AVERAGE RUNNING SPEED ON MAJOR ROAD (mph): 25
AREA POPULATION: 1000000
CONTROL ON EB APPROACH: YIELD SIGN
PEAK HOUR FACTOR: .95

985 HCM: UNSIGNALIZED INTERSECTIONS
****
Vanasse / Hangen Associates

ERSECTION NAME: PURCHASE & OLIVER
LYST: HWH
E OF ANALYSIS: AM PEAK
E OF ANALYSIS: 10/14/86
C.INFO: NO-BUILD AM13NB

INPUT VOLUMES

FULL HOUR VOLUMES (vph)

MOVEMENT	NORTHBOUND	SOUTHBOUND	MINOR (EB)
LEFT	0	0	0
THRU	2495	0	0
RIGHT	0	0	21

GEOMETRY

	NORTHBOUND	SOUTHBOUND	MINOR (EB)
# OF LANES	2	2	1
% GRADE	0	0	0
RT TURN	90	90	90

ADJUSTMENT FACTORS

VEHICLE COMPOSITION

	NORTHBOUND	SOUTHBOUND	MINOR (EB)
% MC'S	0	0	0
% SU/RV'S	0	0	0
% CV'S	7	0	5

AVERAGE RUNNING SPEED ON MAJOR ROAD (mph): 25
AREA POPULATION: 1000000
CONTROL ON EB APPROACH: YIELD SIGN
PEAK HOUR FACTOR: .93

5) CRITICAL GAP ADJUSTMENT TABLE

			TABULAR VALUES	ADJUSTED BY	ACTUAL VALUES
MINOR	EB				
		LT	6	-.5	5.5
		R	4.5	-.5	4
MAJOR	ND				
		LT	5	-.5	4.5

6) LEVEL OF SERVICE RESULTS

MOVEMENT AND LANE USAGE	VOLUME	MOVEMENT CAPACITY	SHARED CAPACITY	RESERVE CAPACITY	LOS
MINOR EB SHARED LANE	12	N.A.	357	345	B

1985 HCM: UNSIGNALIZED INTERSECTIONS
****
Vanasse / Hangen Associates

[illegible]
[illegible]
[illegible]
[illegible] OF ANALYSIS: [illegible]
[illegible] INFO: NO-BUILD PM [illegible]

INPUT VOLUMES

FULL HOUR VOLUMES (vph)
****

MOVEMENT	NORTHBOUND	SOUTHBOUND	MINOR (EB)
LEFT	0	0	0
THRU	2105	0	0
RIGHT	0	0	40

GEOMETRY

	NORTHBOUND	SOUTHBOUND	MINOR (EB)
# OF LANES	2	2	1
% GRADE	0	0	0
RT TURN	90	90	90

ADJUSTMENT FACTORS

VEHICLE COMPOSITION
****

	NORTHBOUND	SOUTHBOUND	MINOR (EB)
% MC'S	0	0	0
% SU/RV'S	0	0	0
% CV'S	4	0	8

AVERAGE RUNNING SPEED ON MAJOR ROAD (mph): 25
AREA POPULATION: 1000000
CONTROL ON EB APPROACH: YIELD SIGN
PEAK HOUR FACTOR: .95

[illegible] UNSIGNALIZED INTERSECTIONS
****

1) CRITICAL GAP ADJUSTMENT TABLE

			TABULAR VALUES	[illegible]	ACTUAL VALUES
			******	*******	*****
MINOR	EB				
		LT	6	.5	5.5
		RT	4.5	-.5	4
MAJOR	NB				
		LT	5	-.5	4.5

2) LEVEL OF SERVICE RESULTS

MOVEMENT AND LANE GROUP	[illegible]	MOV'T CAPACITY	SHARED CAPACITY	RESERVE CAPACITY	LOS
************************	*****	********	********	********	****
MINOR EB SHARED LANE	40	N.A.	459	419	A

1985 HCM: UNSIGNALIZED INTERSECTIONS
****
Vanasse / Hangen Associates

RSECTION NAME: PURCHASE & OLIVER
YST: HWK
OF ANALYSIS: AM PEAK
OF ANALYSIS: 10/14/8[illegible]
INFO: BUILD CONDITIONS AM1994

INPUT VOLUMES

ULL HOUR VOLUMES (vph)
****

MOVEMENT	NORTHBOUND	SOUTHBOUND	MINOR (EB)
********	**********	**********	**********
LEFT	0	0	0
THRU	3107	0	0
RIGHT	0	0	21

GEOMETRY

	NORTHBOUND	SOUTHBOUND	MINOR (EB)
	**********	**********	**********
OF LANES	2	2	1
% GRADE	0	0	0
RT TURN	90	90	90

ADJUSTMENT FACTORS

EHICLE COMPOSITION
****

	NORTHBOUND	SOUTHBOUND	MINOR (EB)
	**********	**********	**********
% MC'S	0	0	0
SU/RV'S	0	0	0
% CV'S	7	0	5

AVERAGE RUNNING SPEED ON MAJOR ROAD (mph): 28
AREA POPULATION: 1000000
CONTROL ON EB APPROACH: YIELD SIGN
PEAK HOUR FACTOR: .93

1985 HCM: UNSIGNALIZED INTERSECTIONS
****

IV. CRITICAL GAP ADJUSTMENT TABLE

			TABLE VALUES	ADJUSTMENT	FINAL VALUE
MINOR	SB				
		LT	6	-.5	5.5
		RT	4.7	[illegible]	4
MAJOR	NB				
		LT	5	-.5	4.5

V. LEVEL OF SERVICE RESULTS

MOVEMENT / LANE TYPE	VOLUME	POTENTIAL CAPACITY	SHARED CAPACITY	RESERVE CAPACITY	LOS
MINOR SB SHARED LANE	12	[illegible]	209	796	[illegible]

EES HCM: UNSIGNALIZED INTERSECTIONS

****

Vanasse / Hangen, Associates

6

SECTION NAME: PURCHASE & OLIVER
IST: PWM
OF ANALYSIS: PM PEAK
E OF ANALYSIS: 10/14/8[illegible]
INFO: BUILD CONDITIONS PM 1994

INPUT VOLUMES

ULL HOUR VOLUMES (vph)

VEMENT	NORTHBOUND	SOUTHBOUND	MINOR (EB)
LEFT	0	0	0
THRU	2197	0	0
RIGHT	0	0	40

GEOMETRY

	NORTHBOUND	SOUTHBOUND	MINOR (EB)
OF LANES	3	0	1
% GRADE	0	0	0
RT TURN	90	90	90

ADJUSTMENT FACTORS

VEHICLE COMPOSITION

	NORTHBOUND	SOUTHBOUND	MINOR (EB)
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]	[illegible]

AVERAGE RUNNING SPEED ON MAJOR ROAD (mph): 3[illegible]
AREA POPULATION: 100000
CONTROL ON EB APPROACH: YIELD SIGN
PEAK HOUR FACTOR: .75

1985 HCM: UNSIGNALIZED INTERSECTIONS
****

1) CRITICAL GAP ADJUSTMENT TABLE

			TABULAR VALUES	ADJUSTMENT	FINAL VALUES
MINOR	EB				
		LT	6	-.5	5.5
		RT	4.5	-.5	4
MAJOR	NB				
		LT	5	-.5	4.5

2) LEVEL OF SERVICE RESULTS

MOVEMENT & LANE	LANE TYPE	VOLUME	POT. CAPACITY	SHARED CAPACITY	RESERVE CAPACITY	LOS
MINOR EB	SHARED LANE	41	N.A.	436	395	B

985 HCM: SIGNALIZED INTERSECTIONS

Vanasse / Hangen Associates

ESECTION: NORTHERN AVENUE AND ATLANTIC AVENUE
LST: RAR
EOF ANALYSIS: AM PEAK
EOF ANALYSIS: 10/03/86
ATYPE: CBD
CINFO: EXISTING CONDITIONS AM14

CAPACITY AND LEVEL OF SERVICE

	BY LANE GROUP						BY APPROACH		
E L	CRIT. MVMT.	V/S FLOW RATIO	CAP.	X V/C RATIO	STOPPED DELAY (SEC/VEH)	LOS	APPROACH	STOPPED DELAY (SEC/VEH)	LOS
R	*	.17	951	.69	39.7	D	WB	39.7	D
TR	*	.54	3220	.71	8.1	B	NB	8.1	B

TERSECTION:	SUM (V/S)c	Xc	DELAY	LOS
	.71	.75	15.2	C

INPUT VOLUMES

MVMT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
LEFT	0	0	0	0
THRU	0	0	1144	0
RIGHT	0	540	735	0
R-O-R	0	0	0	0

R-O-R = RIGHT-ON-RED
VOLUMES DO NOT REFLECT GROWTH FACTOR. SEE SECTION F.

1985 HCM: SIGNALIZED INTERSECTIONS

****

Vanasse / Hangen Associates

INTERSECTION: NORTHERN AVENUE AND ATLANTIC AVENUE
ANALYST: RAP
TIME OF ANALYSIS: PM PEAK
DATE OF ANALYSIS: 09.23.88
AREA TYPE: CBD
MISC.INFO: EXISTING CONDITIONS PM14

A) CAPACITY AND LEVEL OF SERVICE

BY LANE GROUP							BY APPROACH		
LANE GROUP	CRIT. MVMT.	V/S FLOW RATIO	CAP.	X V/C RATIO	STOPPED DELAY (SEC/VEH)	LOS	APPROACH	STOPPED DELAY (SEC/VEH)	LOS
WB R	*	.49	1903	.98	48	E	WB	48	E
NB TR	*	.48	2000	.96	41.1	E	NB	41.1	E

INTERSECTION:	SUM (V/S) =	Xc	DELAY	LOS
	.97	1.02	44.3	E

B) INPUT VOLUMES

MVMT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
LEFT	0	0	0	0
THRU	0	0	1617	0
RIGHT	0	1525	200	0
R-O-R	0	0	0	0

R-O-R = RIGHT-ON-RED
VOLUMES DO NOT REFLECT GROWTH FACTOR SEE SECTION F.

****
Vanasse / Hangen Associates

SECTION: NORTHERN AVENUE AND ATLANTIC AVENUE
ST. RAR
OF ANALYSIS AM PEAK
OF ANALYSIS: 10.03/86
TYPE: CBD
INFO: NO BUILD CONDITION AM14NB

CAPACITY AND LEVEL OF SERVICE

		BY LANE GROUP					BY APPROACH		
	CRIT. MVMT.	V/S FLOW RATIO	CAP.	X V/C RATIO	STOPPED DELAY (SEC/VEH)	LOS	APPROACH	STOPPED DELAY (SEC/VEH)	LOS
TR	*	.63	341	2.61	N.A.	F	EB	N.A.	F
R	*	.21	951	.85	44.9	E	WB	44.9	E
TR	*	.65	2036	1.29	N.A.	F	NB	N.A.	F

DELAY MEANINGLESS WHEN X > 1.2

TERSECTION:	SUM (V/S)c	Xc	DELAY	LOS
	1.51	1.64	N.A.	F

INPUT VOLUMES

VMT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
EFT	0	0	0	0
HRU	542	0	995	0
IGHT	259	664	1183	0
-O-R	0	0	0	0

-O-R = RIGHT-ON-RED
OLUMES DO NOT REFLECT GROWTH FACTOR. SEE SECTION F.

1985 HCM: ...
****
Vanasse / Hangen Associates

INTERSECTION: NORTHERN AVENUE AND ATLANTIC AVENUE
ANALYST: RAR
TIME OF ANALYSIS: PM PEAK
DATE OF ANALYSIS: 10/28/86
AREA TYPE: CBD
MISC.INFO: NO BUILD CONDITION 1994 PM14NB

A) CAPACITY AND LEVEL OF SERVICE

BY LANE GROUP								BY APPROACH		
LANE GROUP		CRIT. MVMT.	V/S FLOW RATIO	CAP.	X V/C RATIO	STOPPED DELAY (SEC/VEH)	LOS	APPROACH	STOPPED DELAY (SEC/VEH)	LOS
EB	TR	*	.26	291	1.23	N.A.	F	EB	N.A.	F
WB	R	*	.65	1110	2.23	N.A.	F	WB	N.A.	F
NB	TR	*	.42	2239	.84	30.7	D	NB	30.7	D

NOTE: DELAY MEANINGLESS WHEN X > 1.2

INTERSECTION:	SUM (V/S)c	Xc	DELAY	LOS
	1.33	1.44	N.A.	F

B) INPUT VOLUMES

MVMT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
LEFT	0	0	0	0
THRU	234	0	1154	0
RIGHT	89	2027	390	0
R-O-R	0	0	0	0

R-O-R = RIGHT-ON-RED
VOLUMES DO NOT REFLECT GROWTH FACTOR. SEE SECTION F.

985 HCM: SIGNALIZED INTERSECTIONS

Vanasse / Hangen Associates

ESECTION: NORTHERN AVENUE AND ATLANTIC AVENUE
LST: RAR
E OF ANALYSIS: AM PEAK
E OF ANALYSIS: 10/10/86
ATYPE: CBD
INFO: BUILD CONDITION 1994 AM14B94

CAPACITY AND LEVEL OF SERVICE

	BY LANE GROUP						BY APPROACH		
	CRIT. MVMT.	V/S FLOW RATIO	CAP.	X V/C RATIO	STOPPED DELAY (SEC/VEH)	LOS	APPROACH	STOPPED DELAY (SEC/VEH)	LOS
TR	*	.65	341	2.61	N.A.	F	EB	N.A.	F
R	*	.22	951	.89	47.9	E	WB	47.9	E
TR	*	.65	2056	1.29	N.A.	F	NB	N.A.	F

DELAY MEANINGLESS WHEN X > 1.2

TERSECTION:	SUM (V/S)c	Xc	DELAY	LOS
	1.52	1.65	N.A.	F

INPUT VOLUMES

MVMT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
LEFT	0	0	0	0
THRU	542	0	995	0
RIGHT	259	694	1183	0
R-O-R	0	0	0	0

R-O-R = RIGHT-ON-RED
VOLUMES DO NOT REFLECT GROWTH FACTOR. SEE SECTION 2.

Vanasse / Hangen Associates

INTERSECTION: NORTHERN AVENUE AND ATLANTIC AVENUE
ANALYST: RAR
TIME OF ANALYSIS: PM PEAK
DATE OF ANALYSIS: 10/28/86
AREA TYPE: CBD
MISC.INFO: BUILD CONDITION 1994 PM14B94

A) CAPACITY AND LEVEL OF SERVICE

BY LANE GROUP								BY APPROACH		
LANE GROUP		CRIT. MVMT.	V/S FLOW RATIO	CAP.	X V/C RATIO	STOPPED DELAY (SEC/VEH)	LOS	APPROACH	STOPPED DELAY (SEC/VEH)	LOS
EB	TR	*	.26	291	1.23	N.A.	F	EB	N.A.	F
WB	R	*	.65	1110	2.23	N.A.	F	WB	N.A.	F
NB	TR	*	.42	2239	.84	30.7	D	NB	30.7	D

NOTE: DELAY MEANINGLESS WHEN X > 1.2

INTERSECTION:	SUM (V/S)c	Xc	DELAY	LOS
	1.33	1.44	N.A.	F

B) INPUT VOLUMES

MVMT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
LEFT	0	0	0	0
THRU	234	0	1154	0
RIGHT	89	2029	390	0
R-O-R	0	0	0	0

R-O-R = RIGHT-ON-RED
VOLUMES DO NOT REFLECT GROWTH FACTOR. SEE SECTION F.

Vanasse / Hangen

:RSECTION: NORTHERN AVENUE AND ATLANTIC AVENUE
.YST: RAR
: OF ANALYSIS: AM PEAK
: OF ANALYSIS: 10/29/86
TYPE: CBD
.INFO: MITIGATION MEASURES FOR THE 1994 BUILD CONDITION AM14B94M

CAPACITY AND LEVEL OF SERVICE

BY LANE GROUP							BY APPROACH		
:E JP	CRIT. MVMT.	V/S FLOW RATIO	CAP.	.X V/C RATIO	STOPPED DELAY (SEC/VEH)	LOS	APPROACH	STOPPED DELAY (SEC/VEH)	LOS
TR	*	.47	858	.93	39.7	D	EB	39.7	D
R	*	.17	1122	.68	39.1	D	WB	39.1	D
T		.24	1122	.98	58.8	E	NB	39.4	D
R	*	.7	1272	.93	21.5	C	NB	39.4	D

ITERSECTION:	SUM (V/S)c	Xc	DELAY	LOS
	1.33	1.4	39.4	D

INPUT VOLUMES

MVMT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
LEFT	0	0	0	0
THRU	542	0	995	0
RIGHT	259	694	1183	0
R-O-R	0	0	0	0

R-O-R = RIGHT-ON-RED
VOLUMES DO NOT REFLECT GROWTH FACTOR. SEE SECTION F.

1985 HCM: SIGNALIZED INTERSECTIONS

Vanasse / Hangen Associates

INTERSECTION: NORTHERN AVENUE AND ATLANTIC AVENUE
ANALYST: RAR
TIME OF ANALYSIS: PM PEAK
DATE OF ANALYSIS: 10/29/86
AREA TYPE: CBD
MISC.INFO: MITIGATION MEASURES FOR THE 1994 BUILD C

A) CAPACITY AND LEVEL OF SERVICE

LANE GROUP		CRIT. MVMT.	V/S FLOW RATIO	CAP.	X V/C RATIO	STOPPED DELAY (SEC/VEH)	LOS	APPROACH	STOPPED DELAY (SEC/VEH)	LOS
BY LANE GROUP								BY APPROACH		
EB	TR	*	.19	372	.87	56.4	E	EB	56.4	E
WB	R	*	.5	2244	.99	42.7	E	WB	42.7	E
NB	T	*	.28	1272	1	N.A.	F	NB	48	E
NB	R		.23	1215	.32	6.5	B	NB	48	E

NOTE: DELAY MEANINGLESS WHEN X > 1.2

INTERSECTION:	SUM (V/S)c	Xc	DELAY	LOS
	.97	1.02	45.9	E

B) INPUT VOLUMES

MVMT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
LEFT	0	0	0	0
THRU	234	0	1154	0
RIGHT	89	2029	390	0
R-O-R	0	0	0	0

R-O-R = RIGHT-ON-RED
VOLUMES DO NOT REFLECT GROWTH FACTOR. SEE SECTION F.

****

Vanasse / Hangen Associates

ESECTION NAME: BROAD & FRANKLIN
LST: RAR
EOF ANALYSIS: AM PEAK
EOF ANALYSIS: 07/27/86
EINFO: EXISTING CONDITION AM15

INPUT VOLUMES

ULL HOUR VOLUMES (vph)
****

OVEMENT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
*******	**********	**********	**********	**********
LEFT	5	153	0	0
THRU	115	263	1	1
RIGHT	46	12	0	0

GEOMETRY

	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
	**********	**********	**********	**********
OF LANES	1	1	1	1
% GRADE	0	0	0	0
RT ANGLE	90	90	90	90

ADJUSTMENT FACTORS

EHICLE COMPOSITION: UNKNOWN
VERAGE RUNNING SPEED ON MAJOR ROAD (mph): 30
REA POPULATION: 1000000
ONTROL ON NB APPROACH: STOP SIGN
ONTROL ON SB APPROACH: STOP SIGN
EAK HOUR FACTOR: .9

D) CRITICAL GAP ADJUSTMENT TABLE

			TABULAR VALUES	ADJUSTED BY	ACTUAL VALUES
MINOR	NB				
		LT	6	-.5	5.5
		TH	5.5	-.5	5
		RT	5	-.5	4.5
MINOR	SB				
		LT	6	-.5	5.5
		TH	5.5	-.5	5
		RT	5	-.5	4.5
MAJOR	EB				
		LT	4.5	-.5	4
MAJOR	WB				
		LT	4.5	-.5	4

E) LEVEL OF SERVICE RESULTS

MOVEMENT AND LANE USAGE		VOLUME	MOV'T CAPACITY	SHARED CAPACITY	RESERVE CAPACITY	LOS
MINOR NB	SHARED LANE	1	N.A.	502	501	A
MINOR SB	SHARED LANE	1	N.A.	490	489	A
MAJOR EB	LEFTS	6	1000	N.A.	994	A
MAJOR WB	LEFTS	168	1000	N.A.	832	A

1985 HCM: UNSIGNALIZED INTERSECTIONS 1

****

Vanasse / Hangen Associates

ERSECTION NAME: BROAD & FRANKLIN
ALYST: RAR
ME OF ANALYSIS: PM PEAK
TE OF ANALYSIS: 09/29/86
SC INFO: EXISTING CONDITION PM15

) INPUT VOLUMES

FULL HOUR VOLUMES (vph)

MOVEMENT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
LEFT	7	51	0	0
THRU	298	89	1	1
RIGHT	84	2	0	0

) GEOMETRY

	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
# OF LANES	1	1	1	1
% GRADE	0	0	0	0
RT ANGLE	90	90	90	90

) ADJUSTMENT FACTORS

VEHICLE COMPOSITION: UNKNOWN
AVERAGE RUNNING SPEED ON MAJOR ROAD (mph): 30
AREA POPULATION: 1000000
CONTROL ON NB APPROACH: STOP SIGN
CONTROL ON SB APPROACH: STOP SIGN
PEAK HOUR FACTOR: .9

D> CRITICAL GAP ADJUSTMENT TABLE

			TABULAR VALUES	ADJUSTED BY	ACTUAL VALUES
MINOR	NB				
		LT	6	-.5	5.5
		TH	5.5	-.5	5
		RT	5	-.5	4.5
MINOR	SB				
		LT	6	-.5	5.5
		TH	5.5	-.5	5
		RT	5	-.5	4.5
MAJOR	EB				
		LT	4.5	-.5	4
MAJOR	WB				
		LT	4.5	-.5	4

E> LEVEL OF SERVICE RESULTS

MOVEMENT AND LANE USAGE		VOLUME	MOV'T CAPACITY	SHARED CAPACITY	RESERVE CAPACITY	LOS
MINOR NB	SHARED LANE	1	N.A.	610	609	A
MINOR SB	SHARED LANE	1	N.A.	579	578	A
MAJOR EB	LEFTS	8	1000	N.A.	992	A
MAJOR WB	LEFTS	56	924	N.A.	868	A

1985 HCM:UNSIGNALIZED INTERSECTIONS
****
Vanasse / Hangen Associates

SECTION NAME: BROAD & FRANKLIN
LST: RAR
ME OF ANALYSIS: [illegible]
E OF ANALYSIS: [illegible]/09/86
INFO: NO BUILD CONDITION 1994 AM15N2

) INPUT VOLUMES

ULL HOUR VOLUMES (vph)
****

OVEMENT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
******	**********	**********	**********	**********
LEFT	6	153	0	0
THRU	149	233	1	1
RIGHT	46	30	0	0

) GEOMETRY

	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
	**********	**********	**********	**********
OF LANES	1	1	1	1
% GRADE	0	0	0	0
RT ANGLE	90	90	90	90

) ADJUSTMENT FACTORS

VEHICLE COMPOSITION: UNKNOWN
AVERAGE RUNNING SPEED ON MAJOR ROAD (mph): 30
AREA POPULATION: 1000000
CONTROL ON NB APPROACH: STOP SIGN
CONTROL ON SB APPROACH: STOP SIGN
[illegible] FACTOR: .9

'85 HCM: UNSIGNALIZED INTERSECTIONS

****

1. CRITICAL GAP ADJUSTMENT TABLE

			TABULAR VALUES	ADJUSTED BY	ACTUAL VALUES
MINOR	NB				
		LT	6	-.5	5.5
		TH	5.5	-.5	5
		RT	5	-.5	4.5
MINOR	SB				
		LT	[illegible]	-.5	5.5
		TH	5.5	-.5	5
		RT	[illegible]	[illegible]	[illegible]
MAJOR	SB				
		LT	4.[illegible]	-.5	[illegible]
MAJOR	EB				
		LT	4.5	-.5	[illegible]

2) LEVEL OF SERVICE RESULTS

MOVEMENT AND LANE USAGE		VOLUME	MOV'T CAPACITY	SHARED CAPACITY	RESERVE CAPACITY	LOS
MINOR NB	SHARED LANE	1	N.A.	409	408	A
MINOR SB	SHARED LANE	1	N.A.	405	404	A
MAJOR EB	LEFTS	7	986	N.A.	979	A
MAJOR WB	LEFTS	[illegible]	[illegible]	N.A.	[illegible]	A

****

Vanasse / Hangen Associates

ERSECTION NAME: BROAD & FRANKLIN
CITY: [illegible]
[illegible]
DATE OF ANALYSIS: 10/09/89
OTHER INFO: NO BUILD CONDITION 1994 PM PEAK & BUILD CONDITIONS 1994

INPUT VOLUMES

ALL HOUR VOLUMES (vph)
****

MOVEMENT *******	EASTBOUND **********	WESTBOUND **********	NORTHBOUND **********	SOUTHBOUND **********
LEFT	7	51	0	0
THRU	298	99	1	1
RIGHT	107	3	0	0

GEOMETRY

	EASTBOUND **********	WESTBOUND **********	NORTHBOUND **********	SOUTHBOUND **********
OF LANES	1	1	1	1
% GRADE	0	0	0	0
RT ANGLE	90	90	90	90

ADJUSTMENT FACTORS

VEHICLE COMPOSITION: UNKNOWN
AVERAGE RUNNING SPEED ON MAJOR ROAD (mph): [illegible]
AREA POPULATION: 1000000
CONTROL ON NB APPROACH: STOP SIGN
CONTROL ON SB APPROACH: STOP SIGN
[illegible]

1985 HCM: UNSIGNALIZED INTERSECTIONS

****

D> CRITICAL GAP ADJUSTMENT TABLE

			TABULAR VALUES	ADJUSTED BY	ACTUAL VALUES
			*******	********	******
MINOR	NB				
		LT	6	-.5	5.5
		TH	5.5	-.5	5
		RT	5	-.5	4.5
MINOR	SB				
		LT	6	-.5	5.5
		TH	5.5	-.5	5
		RT	5	-.5	4.5
MAJOR	EB				
		LT	4.5	-.5	4
MAJOR	WB				
		LT	4.5	-.5	4

E> LEVEL OF SERVICE RESULTS

MOVEMENT AND LANE USAGE		VOLUME	MOV'T CAPACITY	SHARED CAPACITY	RESERVE CAPACITY	LOS
******************		******	********	********	********	*****
MINOR NB	SHARED LANE	1	N.A.	599	598	A
MINOR SB	SHARED LANE	1	N.A.	560	559	A
MAJOR EB	LEFTS	8	1000	N.A.	992	A
MAJOR WB	LEFTS	58	901	N.A.	843	A

Vanasse / Hangen Associates 7

ERSECTION NAME: BROAD & FRANKLIN
T: RAR
E OF ANALYSIS: AM PEAK
E OF ANALYSIS: 10/10/86
. INFO: BUILD CONDITION 1994

INPUT VOLUMES

ULL HOUR VOLUMES (vph)

MOVEMENT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
LEFT	6	153	0	0
THRU	179	283	1	1
RIGHT	46	30	0	0

GEOMETRY

	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
OF LANES	1	1	1	1
% GRADE	0	0	0	0
RT ANGLE	90	90	90	90

ADJUSTMENT FACTORS

HICLE COMPOSITION: UNKNOWN
VERAGE RUNNING SPEED ON MAJOR ROAD (mph): 30
REA POPULATION: 1000000
ONTROL ON NB APPROACH: STOP SIGN
ONTROL ON SB APPROACH: STOP SIGN
EAK HOUR FACTOR: .9

[illegible]:UNSIGNALIZED INTERSECTIONS

1) CRITICAL GAP ADJUSTMENT TABLE

			TABULAR VALUES	ADJUSTED BY	ACTUAL VALUES
MINOR	NB				
		LT	6	-.5	5.5
		TH	5.5	-.5	5
		RT	5	-.5	4.5
MINOR	SB				
		LT	6	-.5	5.5
		TH	5.5	-.5	5
		RT	5	-.5	4.5
MAJOR	EB				
		LT	4.5	-.5	4
MAJOR	WB				
		LT	4.5	-.5	4

2) LEVEL OF SERVICE RESULTS

MOVEMENT AND LANE USAGE		VOLUME	MOVMT CAPACITY	SHARED CAPACITY	RESERVE CAPACITY	LOS
MINOR NB	SHARED LANE	1	N.A.	444	443	A
MINOR SB	SHARED LANE	1	N.A.	437	432	A
MAJOR EB	LEFTS	7	936	N.A.	929	A
MAJOR WB	LEFTS	162	[illegible]	N.A	[illegible]	A

****

Vanasse / Hangen Associates

ERSECTION: BROAD STREET AND SURFACE ARTERY
LYT: RAR
E F ANALYSIS: AM PEAK
E F ANALYSIS: 09/23/86
A YPE: CBD
O.NFO: EXISTING CONDITIONS AM16

CAPACITY AND LEVEL OF SERVICE

		BY LANE GROUP					BY APPROACH		
E G	CRIT. MVMT.	V/S FLOW RATIO	CAP.	X V/C RATIO	STOPPED DELAY (SEC/VEH)	LOS	APPROACH	STOPPED DELAY (SEC/VEH)	LOS
L		.01	230	.04	23.3	C			
R	*	.07	483	.16	17.2	C	EB	17.8	C
.er			138	.29					
.o	*	.15	740	.29	10.5	B			
T.		.3	2553	.36	2.1	A	NB	3.9	A
TR	*	.16	1294	.57	28.5	D	SB	28.5	D

ERSECTION:	SUM (V/S)c	Xc	DELAY	LOS
	.39	.41	13.5	B

INPUT VOLUMES

VMT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
EFT	9	0	245	0
HRU	0	0	853	614
IGHT	75	0	0	28
-O-R	0	0	0	0

-O-R = RIGHT-ON-RED
OLUMES DO NOT REFLECT GROWTH FACTOR. SEE SECTION F.

1985 HCM: SIGNALIZED INTERSECTIONS

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Vanasse / Hangen Associates

9C

INTERSECTION: BROAD STREET AND SURFACE ARTERY
ANALYST: RAR
TIME OF ANALYSIS: PM PEAK
DATE OF ANALYSIS: 09/23/86
AREA TYPE: CBD
MISC.INFO: EXISTING CONDITIONS PM16

4) CAPACITY AND LEVEL OF SERVICE

BY LANE GROUP							BY APPROACH		
LANE GROUP	CRIT. MVMT.	V/S FLOW RATIO	CAP.	X V/C RATIO	STOPPED DELAY (SEC/VEH)	LOS	APPROACH	STOPPED DELAY (SEC/VEH)	LOS
EB L		.01	236	.08	25.9	D			
EB R	*	.15	523	.33	26.1	D	EB	26.1	D
NB Lper			137	.23					
NB Lpro	*	.07	458	.23	17.1	C			
NB T		.41	2631	.5	4.1	A	NB	5.3	B
SB TR	*	.25	2310	.5	23.6	C	SB	23.6	C

INTERSECTION:	SUM (V/S)c	Xc	DELAY	LOS
	.47	.5	14.3	B

5) INPUT VOLUMES

MVMT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
LEFT	17	0	130	0
THRU	0	0	1181	976
RIGHT	164	0	0	13
R-O-R	0	0	0	0

R-O-R = RIGHT-ON-RED
VOLUMES DO NOT REFLECT GROWTH FACTOR. SEE SECTION F.

985 HCM: SIGNALIZED INTERSECTIONS 1
****
Vanasse / Hangen Associates

ERSECTION: BROAD STREET AND SURFACE ARTERY
ST: RAP
E F ANALYSIS: AM PEAK
E F ANALYSIS: 10/03/86
A TYPE: CBD
. INFO: NO BUILD CONDITION 1994 AM16NB

CAPACITY AND LEVEL OF SERVICE

		BY LANE GROUP					BY APPROACH		
	CRIT. MVMT.	V/S FLOW RATIO	CAP.	X V/C RATIO	STOPPED DELAY (SEC/VEH)	LOS	APPROACH	STOPPED DELAY (SEC/VEH)	LOS
L		.01	230	.04	23.3	C			
R	*	.1	483	.24	17.8	C	EB	18.2	C
.er			80	.36					
.TC	*	.19	740	.36	10.4	B			
T		.42	2533	.51	2.7	A	NB	4.1	A
TR	*	.26	1274	.92	36.6	D	SB	36.6	D

TERSECTION:	SUM (V/S)c	Xc	DELAY	LOS
	.55	.59	17.9	C

INPUT VOLUMES

VMT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
EFT	9	0	281	0
HRU	0	0	1202	994
IGHT	109	0	0	40
-O-R	0	0	0	0

-O-R = RIGHT-ON-RED
OLUMES DO NOT REFLECT GROWTH FACTOR. SEE SECTION F.

1985 HCM: SIGNALIZED INTERSECTIONS

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INTERSECTION: [illegible] STREET AND SURFACE ARTERY
ANALYST: [illegible]
TIME OF ANALYSIS: [illegible]
DATE OF ANALYSIS: 10/30/86
AREA TYPE: CBD
ADD.INFO: NO BUILD CONDITION 1994 PM1 [illegible]

4) CAPACITY AND LEVEL OF SERVICE

		BY LANE GROUP						BY APPROACH		
LANE GROUP		CRIT. MVMT.	V/S FLOW RATIO	CAP.	X V/C RATIO	STOPPED DELAY (SEC/VEH)	LOS	APPROACH	STOPPED DELAY (SEC/VEH)	LOS
EB	L		.01	206	.06	23.9	D			
EB	R	*	.15	323	.33	26.1	D	EB	26.1	D
NB	LT		.34	3060	42	3.5	A	NB	3.5	A
SB	TR	*	.37	2710	.79	26.3	D	SB	26.3	D

INTERSECTION:	SUM (V/S)c	Xc	DELAY	LOS
	.54	.57	15.7	C

[illegible] INPUT VOLUMES

MVMT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
LEFT	17	0	131	0
THRU	0	0	1257	1535
RIGHT	154	0	0	13
R-O-R	0	0	0	0

R-O-R = RIGHT-ON-RED
VOLUMES DO NOT REFLECT GROWTH FACTOR SEE SECTION F.

985 HCM: SIGNALIZED INTERSECTIONS 1

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Vanasse / Hangen Associates

ERSECTION: BROAD STREET AND SURFACE ARTERY
LYST: RAR
E OF ANALYSIS: AM PEAK
E OF ANALYSIS: 10/10/85
A TYPE: CBD
INFO: BUILD CONDITION 1994 AM16B94

CAPACITY AND LEVEL OF SERVICE

		BY LANE GROUP					BY APPROACH		
LANE GROUP	CRIT. MVMT.	V/S FLOW RATIO	CAP.	X V/C RATIO	STOPPED DELAY (SEC/VEH)	LOS	APPROACH	STOPPED DELAY (SEC/VEH)	LOS
L		.01	237	.04	23.3	C			
R	*	.12	483	.3	18.4	C	EB	18.7	C
Per			80	.36					
Prc	*	.19	740	.36	10.4	B			
T		.42	2558	.51	2.7	A	NB	4.1	A
TR	*	.27	1294	.94	39.1	D	SB	39.1	D

INTERSECTION:	SUM (V/S)c	Xc	DELAY	LOS
	.58	.63	17.1	C

INPUT VOLUMES

MVMT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
LEFT	9	0	281	0
THRU	0	0	1202	1019
RIGHT	139	0	0	40
R-O-R	0	0	0	0

R-O-R = RIGHT-ON-RED
VOLUMES DO NOT REFLECT GROWTH FACTOR. SEE SECTION F.

1985 HCM: SIGNALIZED INTERSECTIONS
****
Vanasse / Hangen Associates

INTERSECTION: [illegible]
ANALYST: [illegible]
TIME OF ANALYSIS: [illegible]
DATE OF ANALYSIS: 10/10/86
AREA TYPE: CBD
MISC. INFO: BUILD CONDITION 1994 PM
[illegible]

1) CAPACITY AND LEVEL OF SERVICE

LANE GROUP	CRIT. MVMT.		V/S FLOW RATIO	CAP.	X V/C RATIO	STOPPED DELAY (SEC/VEH)	LOS	APPROACH	STOPPED DELAY (SEC/VEH)	LOS
EB	L		.01	236	.08	25.9	D			
EB	R	*	.15	322	.33	26.1	D	EB	26.1	D
NB	LT		.34	3862	.42	3.5	A	NB	3.5	A
SB	TR	*	.39	2210	.79	25.5	D	SB	25.5	D

BY LANE GROUP / BY APPROACH

INTERSECTION:	SUM (V/S)c	Xc	DELAY	LOS
	.54	.57	13.8	C

2) INPUT VOLUMES

MVMT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
LEFT	17	0	131	0
THRU	0	0	1257	1538
RIGHT	164	0	0	13
R-O-R	0	0	0	0

R-O-R = RIGHT ON-RED
VOLUMES DO NOT REFLECT GROWTH FACTOR. SEE SECTION 7.

****

- Vanasse / Hangen Associates

95

ERECTION: HIGH STREET & ATLANTIC AVENUE AND SURFACE ARTERY
LYT: RAR
E F ANALYSIS: AM PEAK
E F ANALYSIS: 09/29/86
A YPE: CBD
O.NFO: EXISTING CONDITIONS AM17

CAPACITY AND LEVEL OF SERVICE

		BY LANE GROUP					BY APPROACH		
E UF	CRIT. MVMT.	V/S FLOW RATIO	CAP.	X V/C RATIO	STOPPED DELAY (SEC/VEH)	LOS	APPROACH	STOPPED DELAY (SEC/VEH)	LOS
L	*	.15	514	.85	36.3	D			
T		.03	274	.18	32.3	D	EB	35.9	D
L		.14	634	.6	24.5	C			
T	*	.3	344	1.28	N.A.	F	WB	N.A.	F
.ar			80	.84					
. o		.29	319	.84	32.8	D			
T	*	.51	907	.86	20.7	C	NB	25.5	D
TR		.18	1113	.75	31.7	D	SB	31.7	D

E DELAY MEANINGLESS WHEN X > 1.2

TERSECTION:	SUM (V/S)c	Xc	DELAY	LOS
	.96	1.06		E

INPUT VOLUMES

VMT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
EFT	375	326	453	0
HRU	43	397	701	603
IGHT	0	0	0	86
-O-R	0	0	0	0

-O-R = RIGHT-ON-RED
OLUMES DO NOT REFLECT GROWTH FACTOR. SEE SECTION F.

1985 HCM: SIGNALIZED INTERSECTIONS
****
Vanasse / Hangen Associates

96

INTERSECTION: HIGH STREET & ATLANTIC AVENUE AND SURFACE ARTERY
ANALYST: RAR
TIME OF ANALYSIS: PM PEAK
DATE OF ANALYSIS: 09/29/85
AREA TYPE: CBD
MISC.INFO: EXISTING CONDITIONS PM17

A) CAPACITY AND LEVEL OF SERVICE

BY LANE GROUP							BY APPROACH		
LANE GROUP	CRIT. MVMT.	V/S FLOW RATIO	CAP.	X V/C RATIO	STOPPED DELAY (SEC/VEH)	LOS	APPROACH	STOPPED DELAY (SEC/VEH)	LOS
EB L	*	.21	521	1.14	N.A.	F			
EB T		.08	277	.45	52.9	E	EB	N.A.	F
WB L		.32	706	1.22	N.A.	F			
WB T	*	.34	384	1.3	N.A.	F	WB	N.A.	F
NB Lper			72	.57					
NB Lpro		.06	151	.36	31.6	D			
NB T	*	.62	862	1.11	N.A.	F	NB	N.A.	F
SB TR		.3	2104	.66	24.7	C	SB	24.7	C

NOTE: DELAY MEANINGLESS WHEN X > 1.2

INTERSECTION:	SUM (V/S)L	XL	DELAY	LOS
	1.17	1.28	N.A.	F

B) INPUT VOLUMES

MVMT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
LEFT	510	737	113	0
THRU	112	449	862	1007
RIGHT	0	0	0	133
R-O-R	0	0	0	0

R-O-R = RIGHT-ON-RED
VOLUMES DO NOT REFLECT GROWTH FACTOR. SEE SECTION F.

****

Vanasse / Hangen Associates

97

INTERSECTION: HIGH STREET & AT AND SURFACE ARTERY
ANALYST: RAR
DATE OF ANALYSIS: [illegible]
TIME OF ANALYSIS: [illegible]
AREA TYPE: CBD
COMMENT: NO BUILD CONDITION 1994 AM17NB

CAPACITY AND LEVEL OF SERVICE

LANE GROUP	CRIT. MVMT.	V/S FLOW RATIO	CAP.	X V/C RATIO	STOPPED DELAY (SEC/VEH)	LOS	APPROACH	STOPPED DELAY (SEC/VEH)	LOS
BY LANE GROUP							BY APPROACH		
L	*	.11	514	.62	27.7	D			
T		.1	374	.53	37.8	D	EB	31.1	D
L		.17	634	.81	30.3	D			
T	*	.31	344	1.32	N.A.	F	WB	N.A.	F
[illegible]			80	1.92					
[illegible]	*	.44	519	1.87	N.A.	F			
T		.77	907	1.32	N.A.	F	NB	N.A.	F
TR	*	.3	1034	1.24	N.A.	F	SB	N.A.	F

STOPPED DELAY MEANINGLESS WHEN X > 1.2

INTERSECTION:	SUM (V/S)c	X=	DELAY	LOS
	1.37	1.52	N.A.	F

INPUT VOLUMES

MVMT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
LEFT	275	441	1009	0
THRU	143	409	1074	767
RIGHT	0	0	0	306
R-O-R	0	0	0	0

R-O-R = RIGHT-ON-RED
VOLUMES DO NOT REFLECT GROWTH FACTOR. SEE SECTION F.

1985 HCM: SIGNALIZED INTERSECTIONS

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Vanasse / Hangen Associates .

INTERSECTION: HIGH STREET & AT AND SURFACE ARTERY
ANALYST: [illegible]
TIME OF ANAL SIS: [illegible]
DATE OF ANALYSIS: 10/14/9[illegible]
AREA TYPE: CBD
1.SC.INFO: NO BUILD CONDITION 1994 PM117NB

A) CAPACITY AND LEVEL OF SERVICE

BY LANE GROUP							BY APPROACH		
LANE GROUP	CRIT. MVMT.	V/S FLOW RATIO	CAP.	X V/C RATIO	STOPPED DELAY (SEC/VEH)	LOS	APPROACH	STOPPED DELAY (SEC/VEH)	LOS
EB L		.15	521	.81	36.2	D			
EB T	*	.19	277	1.05	N.A.	F	EB	N.A.	F
WB L	*	.32	706	1.23	N.A.	F			
WB T		.31	384	1.2	N.A.	F	WB	N.A.	F
NB LT	*	.52	1127	1.03	N.A.	F	NB	N.A.	F
SB TR		.57	2040	1.03	N.A.	F	SB	N.A.	F

NOTE: DELAY MEANINGLESS WHEN X > 1.2

INTERSECTION:	SUM (V/S)c	Xc	DELAY	LOS
	1.09	1.19	N.A.	F

B) INPUT VOLUMES

MVMT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
LEFT	360	743	122	0
THRU	262	415	873	1136
RIGHT	0	0	0	586
R-O-R	0	0	0	0

R-O-R = RIGHT-ON-RED
VOLUMES DO NOT REFLECT GROWTH FACTOR. SEE SECTION F.

Vanasse / Hangen Associates

97

RSECTION: HIGH STREET & AT AND SURFACE ARTERY
LYST: RAR
E F ANALYSIS: AM PEAK
E F ANALYSIS: 10/14/90
TYPE: CBD
I.NFO: BUILD CONDITION 1994 AM17394

CAPACITY AND LEVEL OF SERVICE

		BY LANE GROUP					BY APPROACH		
E GP	CRIT. MVMT.	V/S FLOW RATIO	CAP.	X V/C RATIO	STOPPED DELAY (SEC/VEH)	LOS	APPROACH	STOPPED DELAY (SEC/VEH)	LOS
L	*	.11	514	.62	27.7	D			
T		.1	271	.53	37.8	D	EB	31.1	D
L		.2	634	.87	33.7	D			
T	*	.31	344	1.32	N.A.	F	WB	N.A.	F
L			3[illegible]	2.19					
L	*	.89	518	2.39	N.A.	F			
T		.77	907	1.32	N.A.	F	NB	N.A.	F
TR	*	.30	1093	1.27	N.A.	F	SB	N.A.	F

E DELAY MEANINGLESS WHEN X > 1.2

ERSECTION:	SUM (V/S)c	Xc	DELAY	LOS
	1.62	1.81	N.A.	F

INPUT VOLUMES

MVMT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
LEFT	273	471	1395	0
THRU	143	409	1074	822
RIGHT	0	0	0	336
RTOR	0	0	0	0

RTOR = RIGHT-ON-RED
VOLUMES DO NOT REFLECT GROWTH FACTOR. SEE SECTION F.

1985 HCM: SIGNALIZED INTERSECTIONS
****
Vanasse / Hangen Associates

i00

[illegible] HIGH STREET [illegible] AND [illegible]
[illegible]
[illegible]
DATE OF ANALYSIS: 10/14/[illegible]
AREA TYPE: CBD
[illegible] INFO: BUILD CONDITION 1994 PM[illegible]

A) CAPACITY AND LEVEL OF SERVICE

			BY LANE GROUP					BY APPROACH		
LANE GROUP	CRIT. MVMT.	V/S FLOW RATIO	CAP.	X V/C RATIO	STOPPED DELAY (SEC/VEH)	LOS	APPROACH	STOPPED DELAY (SEC/VEH)	LOS
EB	L		.15	521	.81	36.2	D	EB	N.A.	F
EB	T	*	.19	277	1.05	N.A.	F			
WB	L	*	.32	706	1.23	N.A.	F	WB	N.A.	F
WB	T		.37	384	1.2	N.A.	F			
NB	LT	*	.62	1074	1.11	N.A.	F	NB	N.A.	F
SB	TR		.6[illegible]	2040	1.07	N.A.	F	SB	N.A.	F

NOTE: DELAY MEANINGLESS WHEN X > 1.2

INTERSECTION:	SUM (V/S)c =	Xc =	DELAY	LOS
	1.15	1.04	N.A.	F

B) INPUT VOLUMES

MVMT	EASTBOUND	WESTBOUND	NORTHBOUND	SOUTHBOUND
LEFT	360	743	146	0
THRU	262	413	873	1139
RIGHT	0	0	0	526
R-O-R	0	0	0	0

R-O-R = RIGHT-ON-RED
VOLUMES DO NOT REFLECT GROWTH FACTOR. SEE SECTION F.

APPENDIX B

WIND ANALYSIS

APPENDIX B

WIND ANALYSIS

SECTION B-1: SAND SCOUR RESULTS

SECTION B-2: THE DEFINITION OF WIND CLIMATE

SECTION B-3: POLAR PLOTS OF MEAN AND GUST WIND SPEEDS

SECTION B-4: COMPARISON OF POLAR PLOTS OF MEAN AND GUST WIND SPEEDS FOR THE CURRENT STUDY WITH THE PREVIOUS MASSINGS STUDY

SECTION B-5: COMPARISON OF POLAR PLOTS OF MEAN AND GUST WIND SPEEDS FOR THE CURRENT STUDY WITH THE INTERNATIONAL PLACE STUDY

SECTION B-1

SAND SCOUR RESULTS

24 FPS

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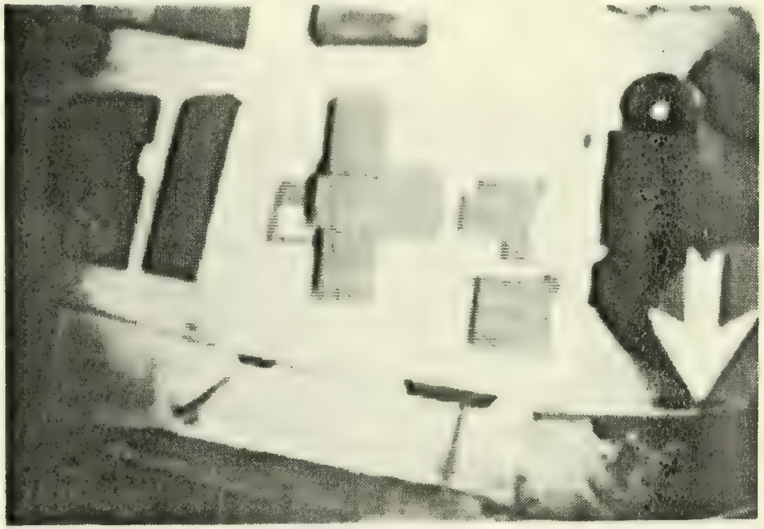

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FIG. B-1 SAND SCOUR PATTERNS; PRESENT SITE, WIND DIRECTION: NORTHWEST

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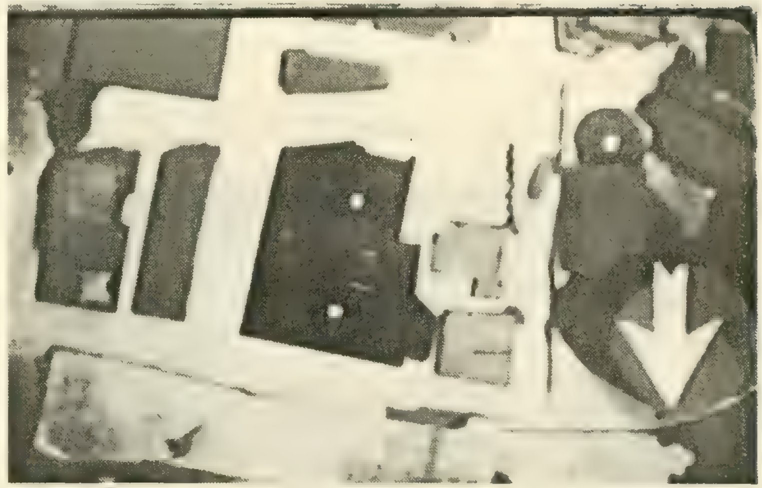

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FIG. B-2 SAND SCOUR PATTERNS; PHASE I, WIND DIRECTION: NORTHWEST

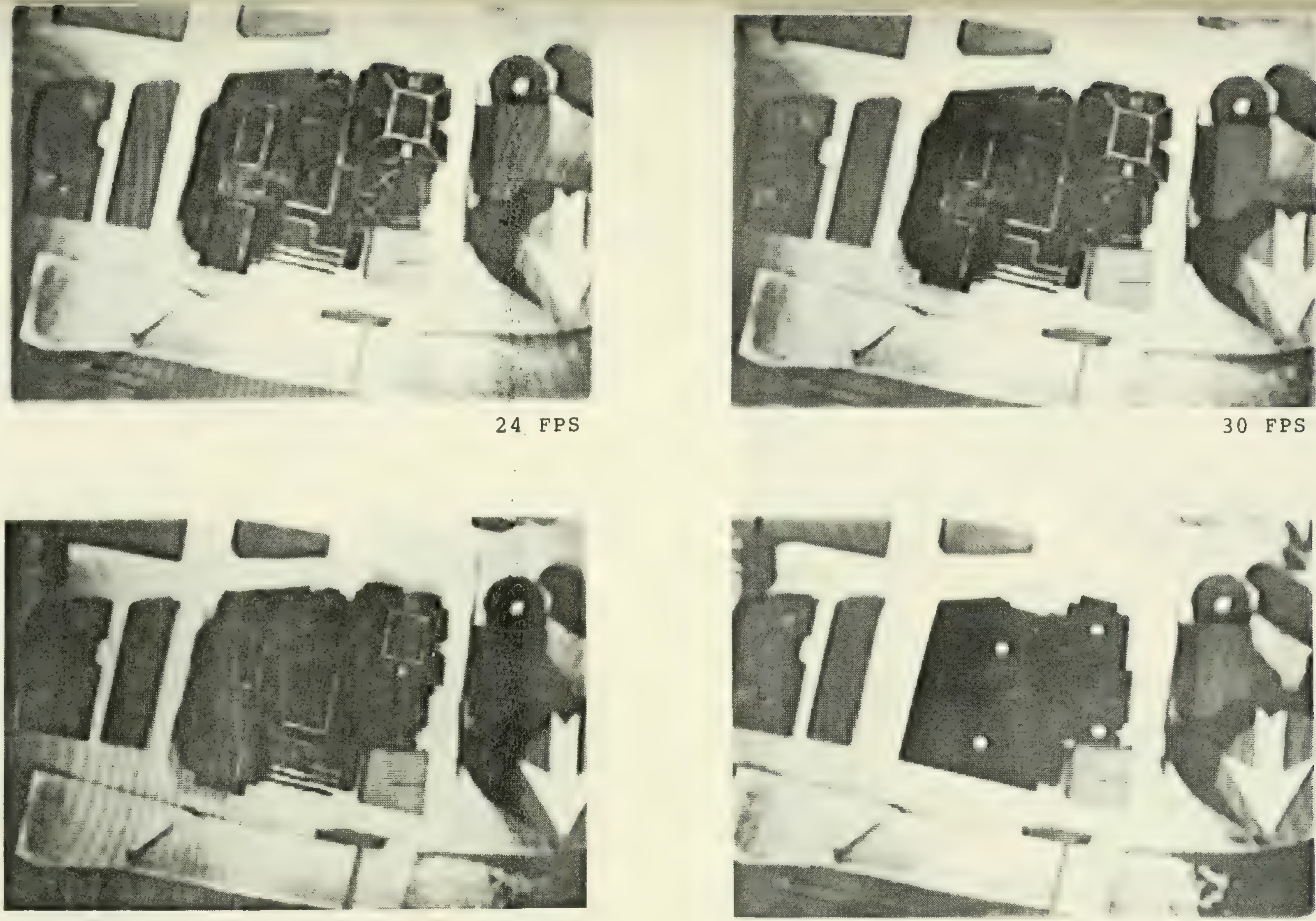

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FIG. B-3 SAND SCOUR PATTERNS; PHASE II, WIND DIRECTION: NORTHWEST

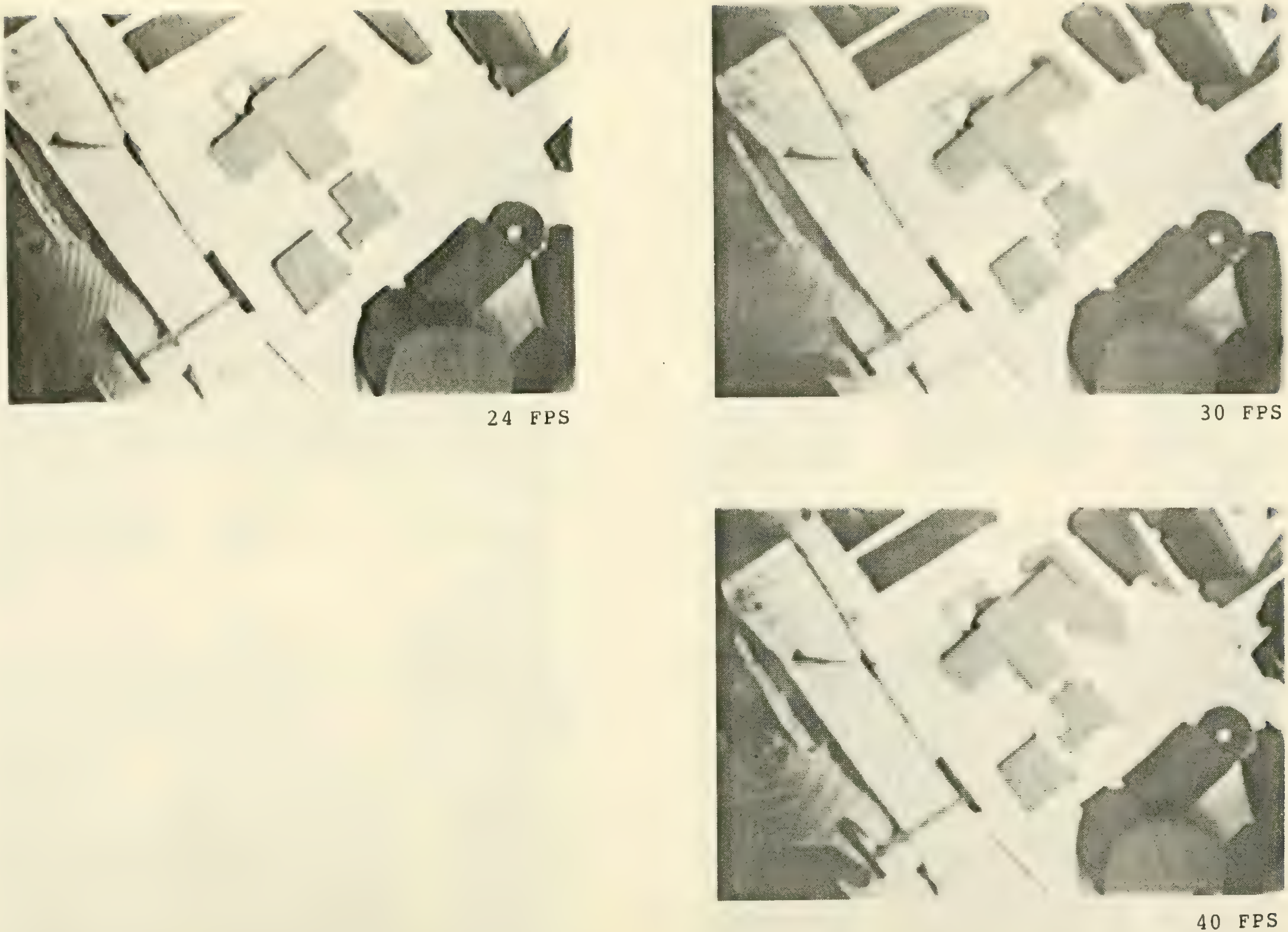

FIG. B-4 SAND SCOUR PATTERNS; PRESENT SITE, WIND DIRECTION: WEST

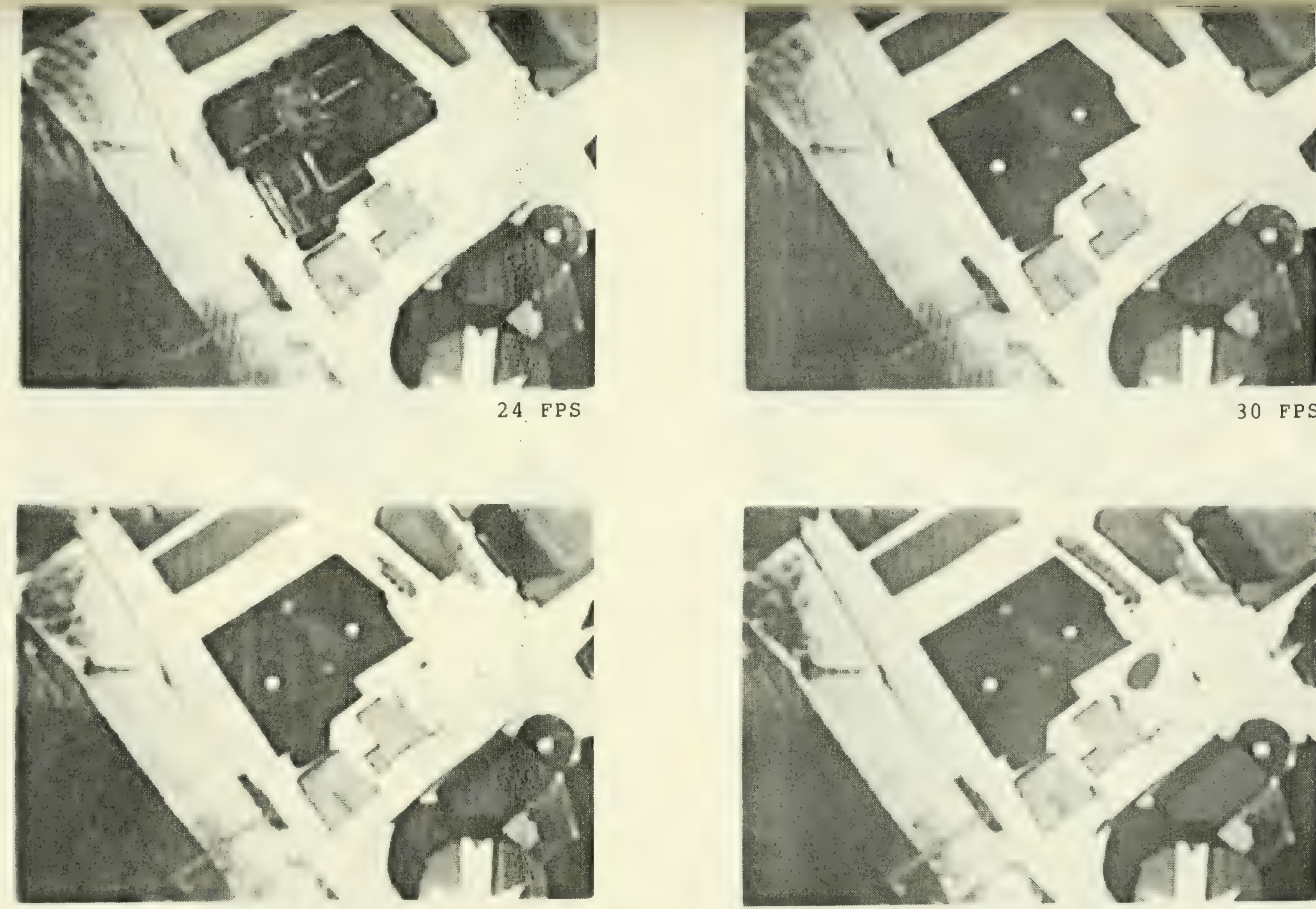

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FIG. B-5 SAND SCOUR PATTERNS; PHASE I, WIND DIRECTION: WEST

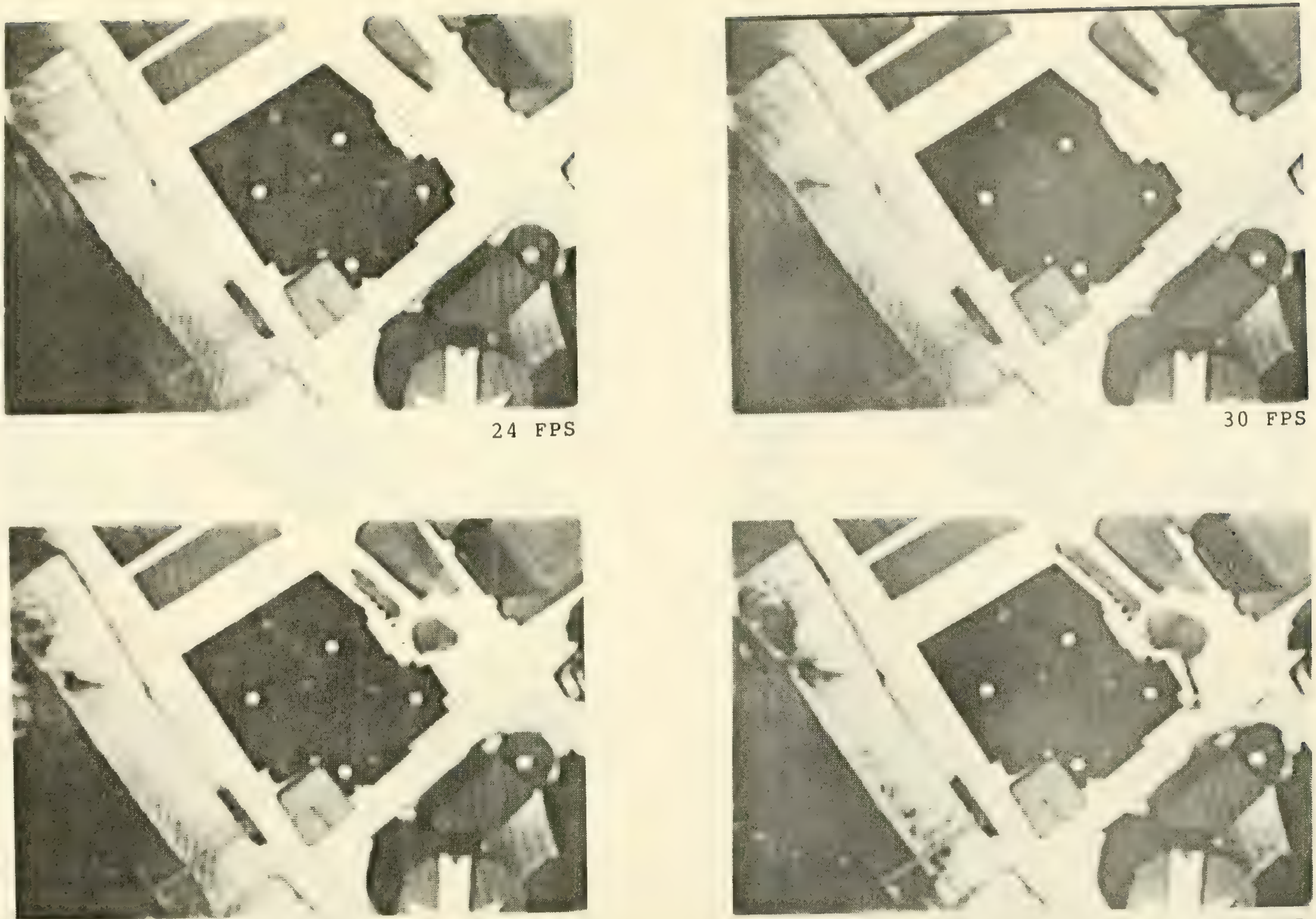

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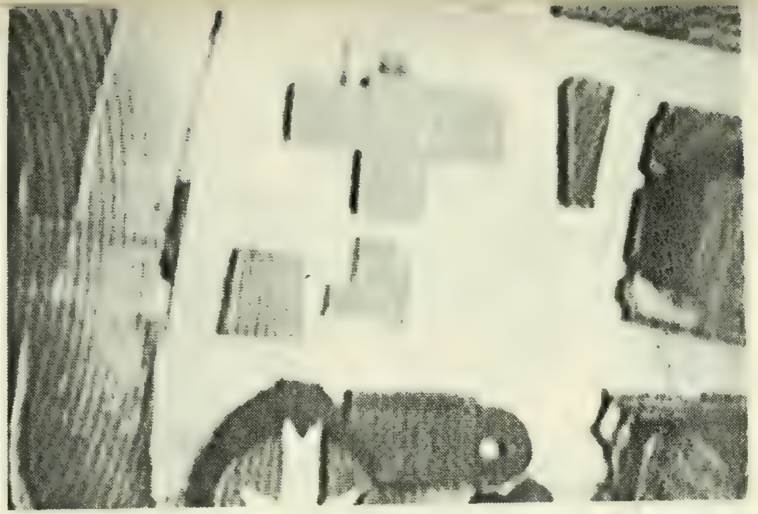
FIG. B-6 SAND SCOUR PATTERNS; PHASE II, WIND DIRECTION: WEST



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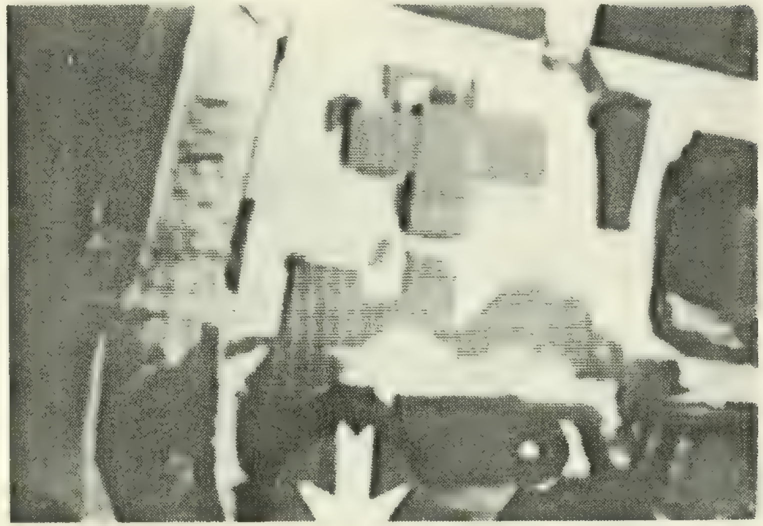

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FIG. B-7   SAND SCOUR PATTERNS; PRESENT SITE, WIND DIRECTION: SOUTHWEST

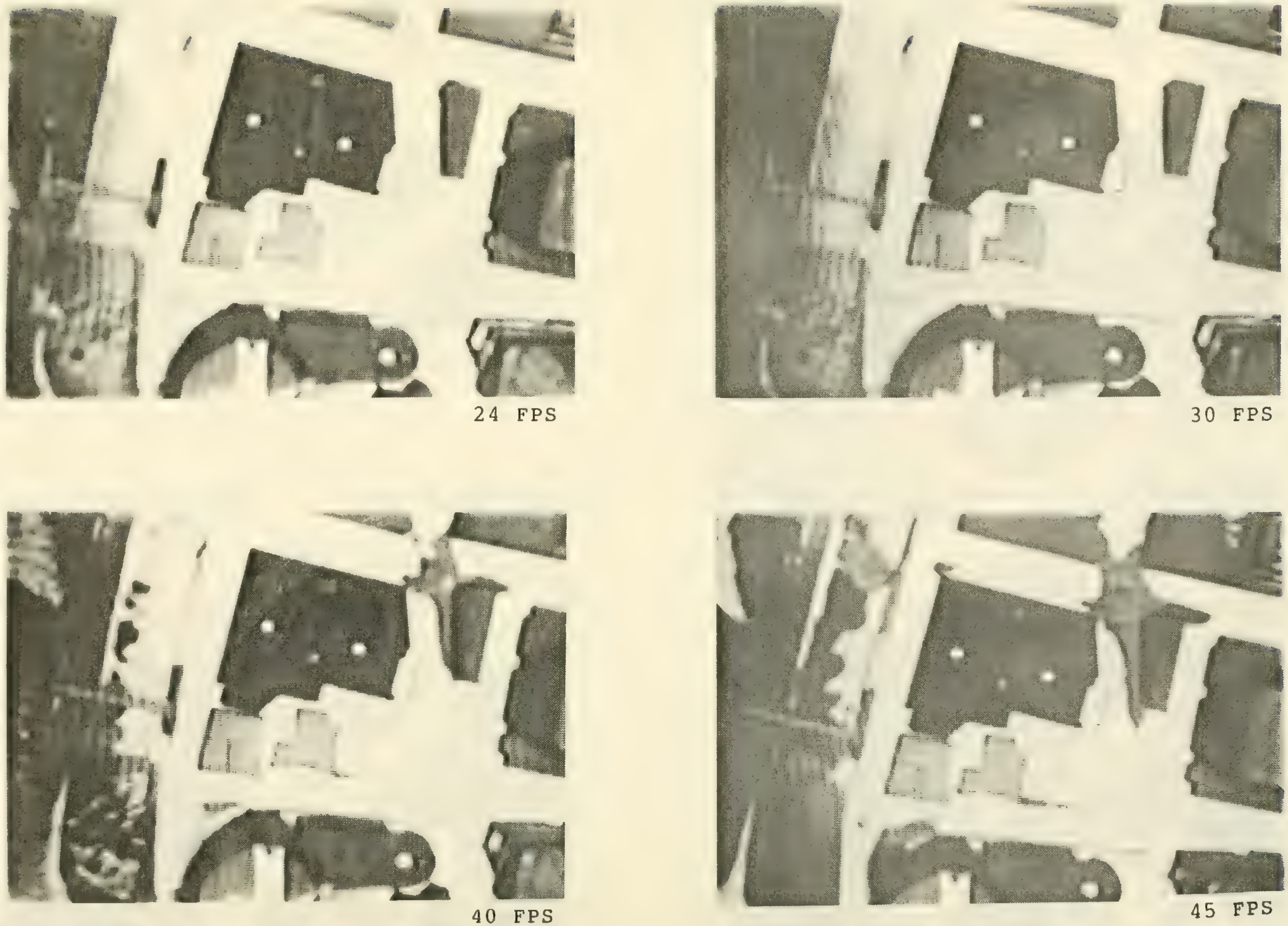

FIG. B-8 SAND SCOUR PATTERNS; PHASE I, WIND DIRECTION: SOUTHWEST

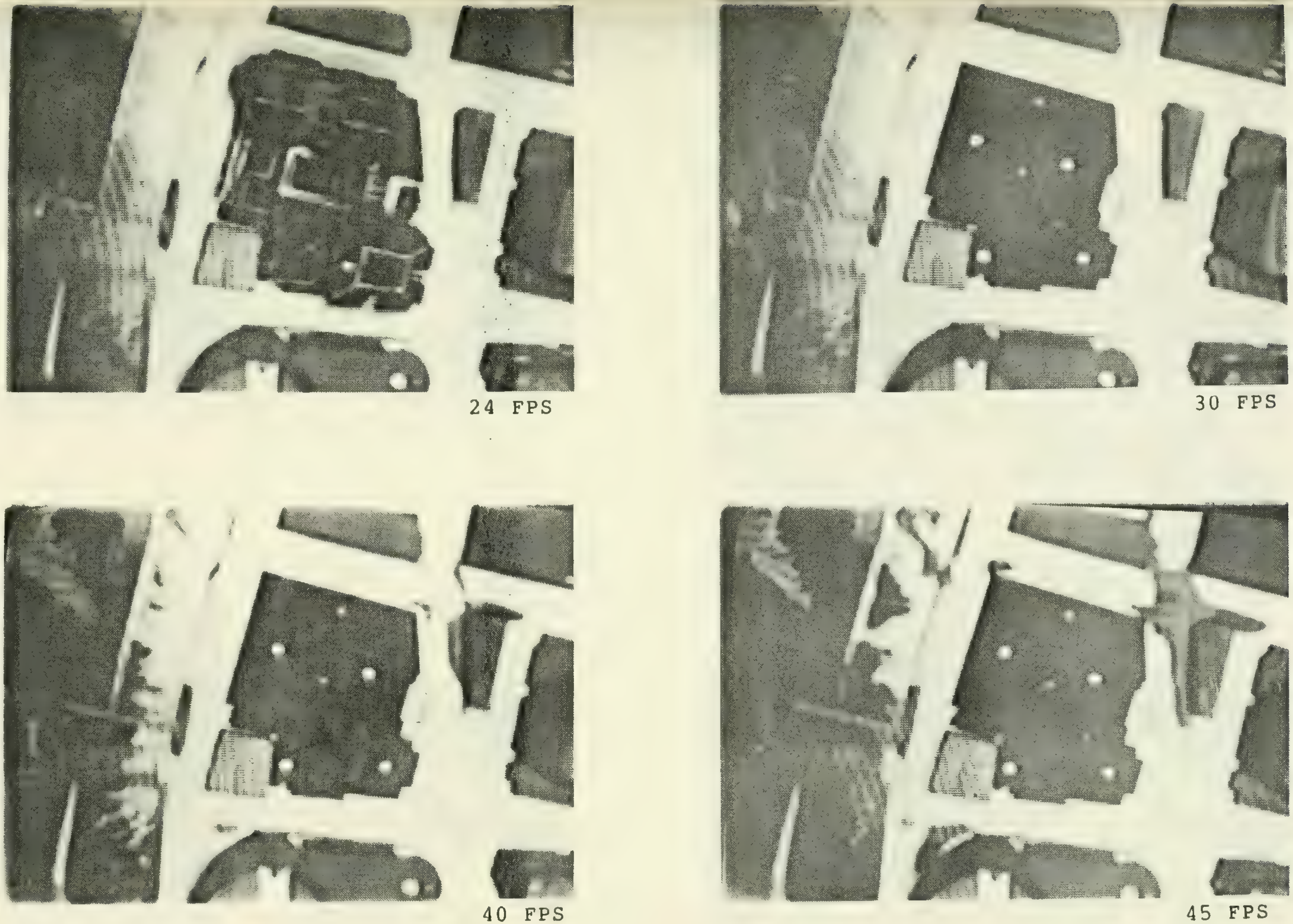

FIG. B-9 SAND SCOUR PATTERNS; PHASE II, WIND DIRECTION: SOUTHWEST

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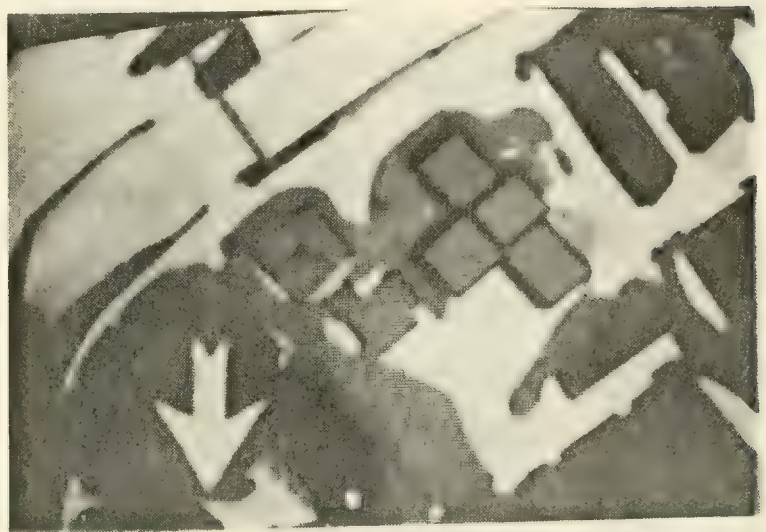

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FIG. B-10 SAND SCOUR PATTERNS; PRESENT SITE, WIND DIRECTION: SOUTH

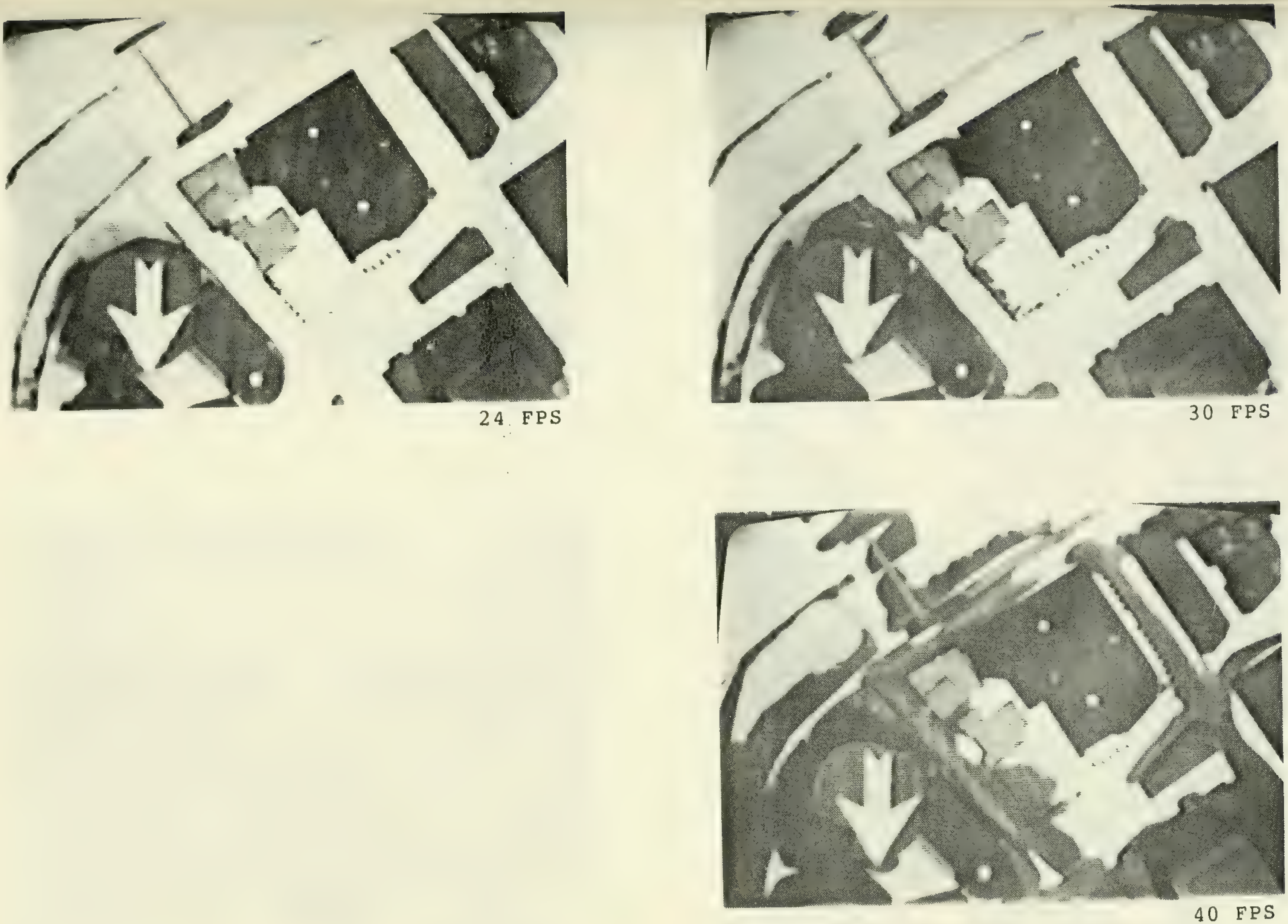
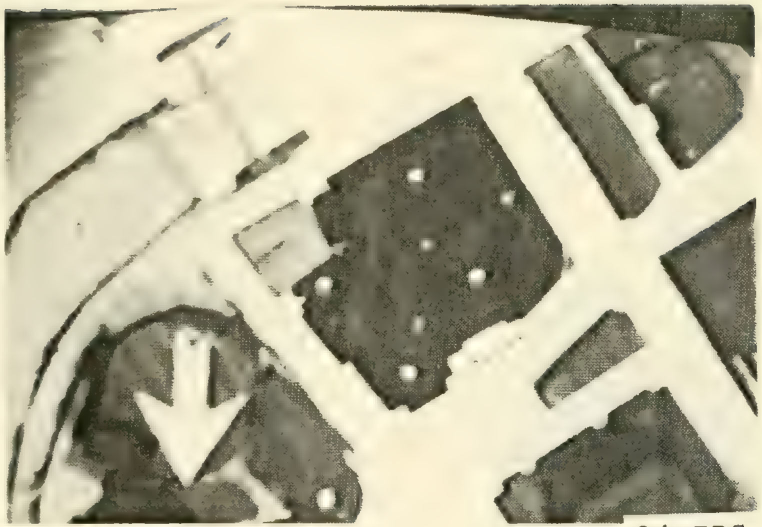


FIG. B-11 SAND SCOUR PATTERNS; PHASE I, WIND DIRECTION: SOUTH



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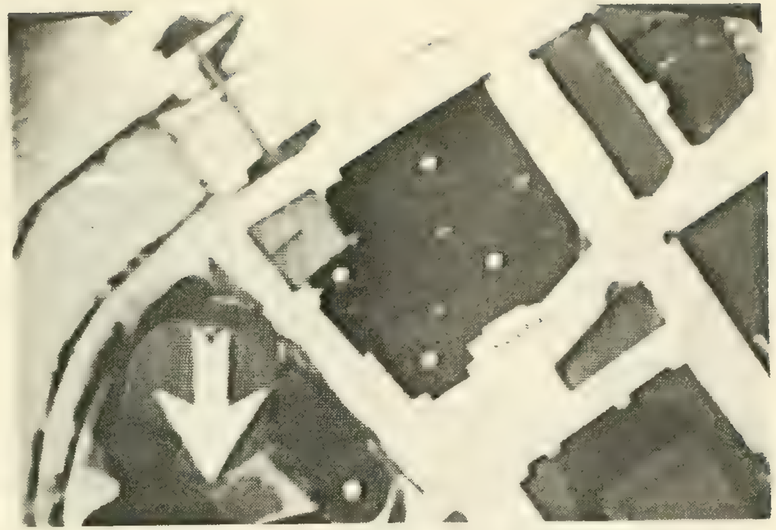

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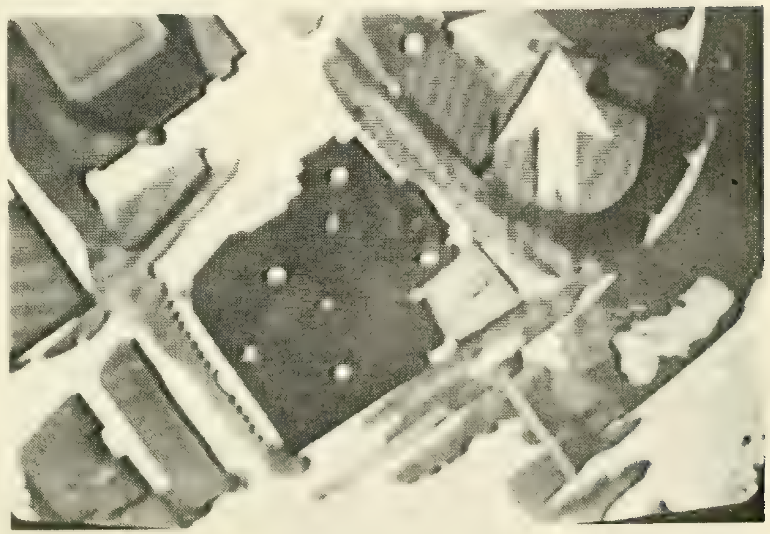

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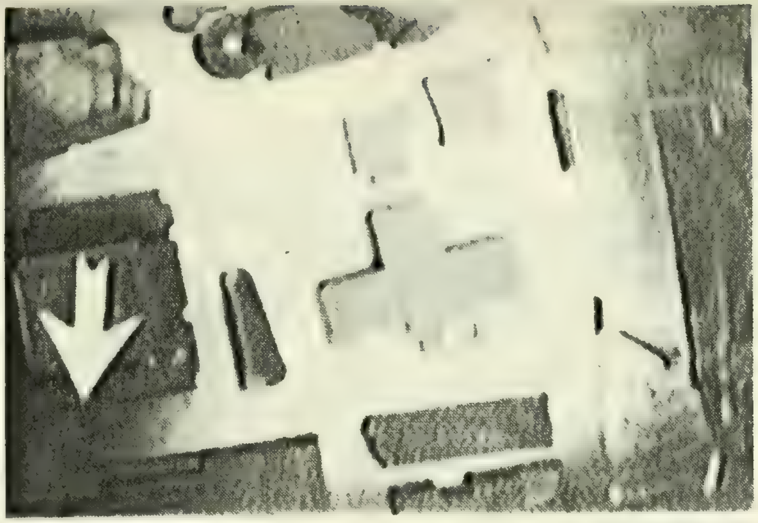
FIG. B-12 SAND SCOUR PATTERNS; PHASE II, WIND DIRECTION: SOUTH



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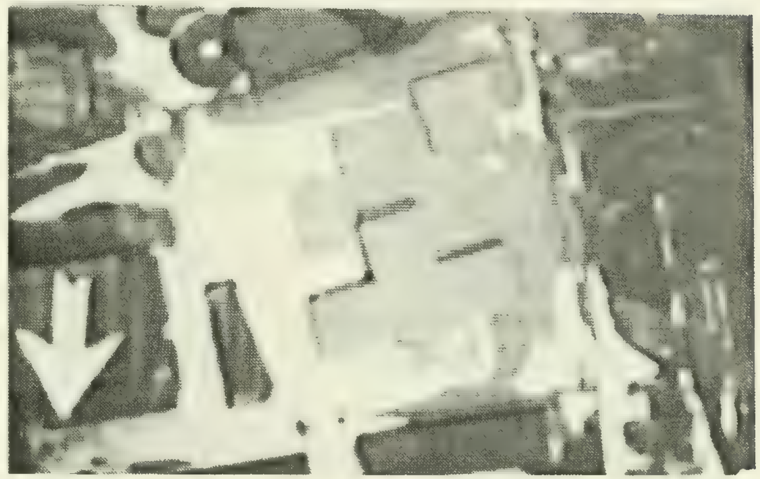

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FIG. B-13 SAND SCOUR PATTERNS; PRESENT SITE, WIND DIRECTION: EAST NORTHEAST

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FIG. B-14 SAND SCOUR PATTERNS; PHASE I, WIND DIRECTION: EAST NORTHEAST

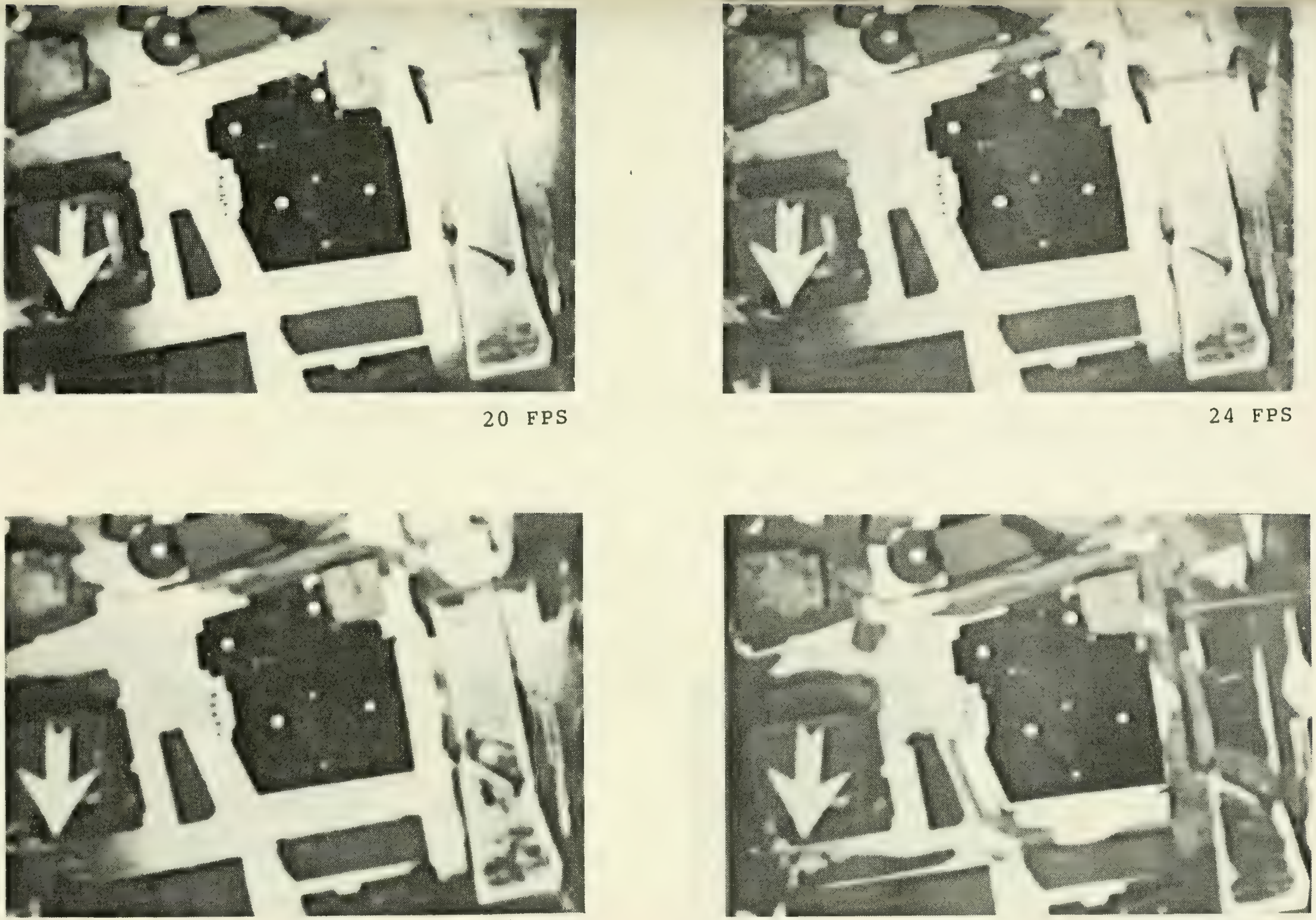

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FIG. B-15 SAND SCOUR PATTERNS; PHASE II, WIND DIRECTION: EAST NORTHEAST

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FIG. B-16 SAND SCOUR PATTERNS; PHASE II, WIND DIRECTION: SOUTHWEST, NORTHWEST CORNER CUT-OFF UNDER OVERHANG

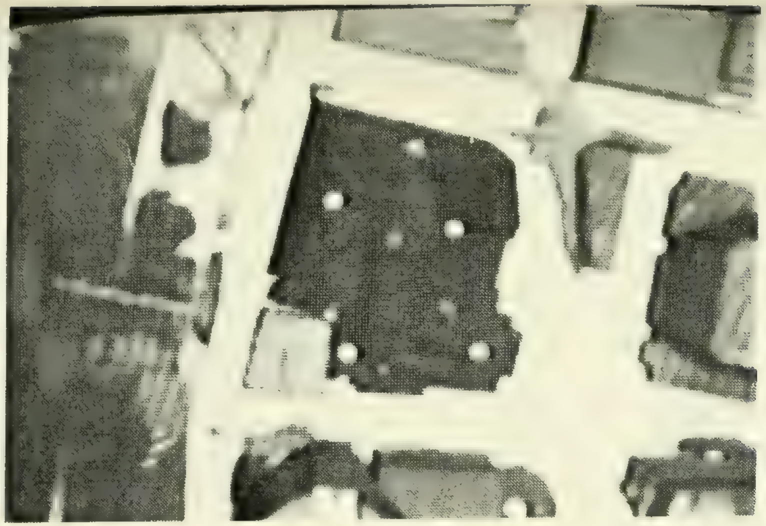

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FIG. B-17 SAND SCOUR PATTERNS; PHASE II, WIND DIRECTION: SOUTHWEST, NORTHWEST CORNER CUT-OFF UNDER OVERHANG, GAPS BETWEEN SOME COLUMNS SEALED (SEE TEXT)

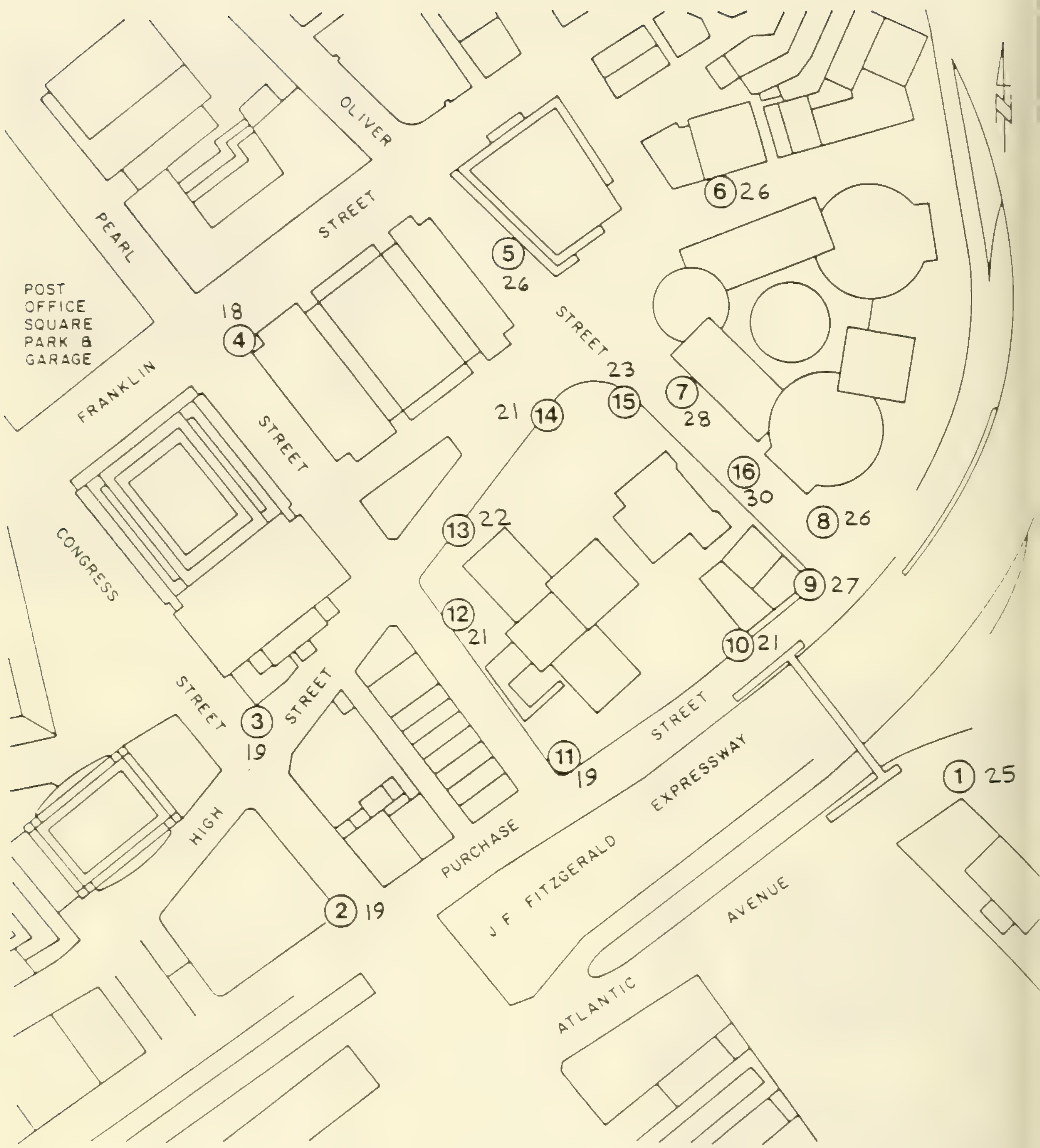


FIG. B-18 GUST WIND SPEEDS EXPECTED TO BE EXCEEDED 1% OF THE TIME FOR T CURRRENT SITE CONFIGURATION, FROM REFERENCE 1

SECTION B-2

THE DEFINITION OF WIND CLIMATE

THE DEFINITION OF WIND CLIMATE

INTRODUCTION

The provision of statistical predictions of full scale wind induced effects for design purposes requires definition of both the dependence of particular response parameters on wind speed and direction and the statistical properties of the local wind climate. The former can usually only be obtained from wind tunnel simulations. With a correct modeling of the salient properties of natural wind and the particular system or phenomenon of concern, the role of the wind tunnel is essentially that of an analogue computer. Typically, for particular mean wind speeds and wind directions, such simulations provide detailed information on overall wind induced forces and responses of buildings and structures, wind induced peak pressures on particular structural or building elements such as windows or cladding, pedestrian level wind speeds, performance of power generators, diffusion of pollutants, etc. Probabilistic predictions of particular full scale effects are subsequently obtained by combining the wind tunnel derived data with the probability distribution of the mean wind speed and direction obtained independently from an analysis of full scale wind records.

The justification for this approach, in which the wind tunnel is used to simulate the turbulent properties of natural wind associated with a particular mean wind speed, is briefly described below. Also presented is a brief description of available wind records, and the methodology for defining the probability distribution of the mean wind speed and direction.

NATURAL WIND

For slowly moving pressure systems, the motion of air at heights above the influence of the earth's surface is essentially parallel to the isobars and governed by the pressure gradient, the Coriolis acceleration and the centrifugal acceleration due to isobar curvature (A-1). If the wind is such that these three effects are in balance, it is referred to as the gradient wind, and as the geostrophic wind if there is no isobar curvature. The height at which this balance is first approximately achieved, that is, the height where frictional effects due to the earth's surface cease to be significant, is termed the gradient height. During periods of neutral atmospheric stability, typical of strong wind conditions, the gradient height or depth of the earth's boundary layer is determined largely by the terrain roughness and typically varies from about 900 feet over open country to about 1700 feet over built-up urban areas (A-2, A-3). As used throughout this report, the term gradient wind refers to the measured wind at approximately 500 m. This usage is not in exact agreement with the above definition but does provide a convenient terminology.

Within the atmospheric boundary layer the flow becomes increasing more dependent on shear stresses of mechanical and buoyant origin. The mean wind speed within the atmospheric boundary layer increases markedly with height above ground and the orientation of the mean wind speed vector rotates somewhat with respect to its direction near the surface. This horizontal rotation or veering with height is clockwise in the northern hemisphere. Based on theoretical arguments, the

resulting relationships between the surface and gradient mean wind speed and direction during neutrally stable atmospheric conditions depend on the Rossby number which relates shear forces to forces from the Coriolis acceleration (A-2). However, Davenport (A-3) and others (A-4) have shown that the ratio of the surface to gradient wind speed is relatively insensitive to both the latitude and the gradient wind speed and depends primarily on the upstream terrain roughness. For practical purposes, therefore, the vertical variation of the mean wind speed within the earth's boundary layer, during neutrally stable atmospheric conditions, can be taken to depend only on the terrain roughness. Estimates of the angular shift between surface and gradient height for open terrain, typical of most anemometer locations, is generally of the order of the angular resolution of the measured wind direction. For wind engineering purposes, corrections for the rotation between the surface and gradient wind vectors are not justified. Consequently, natural wind over a particular terrain can be simulated by a turbulent boundary layer flow developed in a wind tunnel over a long fetch of appropriate model terrain roughness. Details of this approach, which leads to a representative simulation of the mean flow structure and the turbulent flow characteristics are given elsewhere (A-5). The variation of the mean wind speed with height is conveniently described by the power law profile.

$$V(z) = V_g \left(\frac{z}{z_g} \right)^m \tag{A.1}$$

where $V(z)$ is the mean wind speed at height z; V_g is the gradient wind speed for the same azimuth; and z_g and m are the gradient height and the power law exponent respectively. In general both z_g and m depend on the wind direction.

Examining the power spectrum of all wind speed variations (the power spectrum indicates the distribution of energy with frequency), a distinct gap is found to exist at periods of about one hour (A-2, A-6, A-7). This spectral gap conveniently separates atmospheric motion into two distinct categories; namely, turbulent with locally stationary statistical properties, and quasi-steady mean speeds associated with slowly varying synoptic or climatological time scales. This characteristic justifies the use of a wind tunnel generated turbulent boundary layer flow to simulate natural wind at a particular location and for particular mean wind speeds and wind directions. The latter are then systematically varied to obtain a complete description of a particular process.

AVAILABILITY OF WIND RECORDS

Wind records in the form of relative frequency of occurrence of various wind speeds from different directions are available for most cities in North America.

For many cities such records are available for both surface winds and for upper level winds measured at various heights above the ground. Measurements of the surface wind speed and direction are normally available from mast-mounted anemometers and directional vanes operated at synoptic and climatological stations and in some cases at pollution control or monitoring stations. The standard height for such measurements is 10 meters above ground. Upper level data are available only from meteorological stations equipped for tracking weather balloons either visually as for pilot balloons (pibals) or automatically as for radiosonde (rawinsonde) ascents. In the latter case, an instrument package equipped with a radio transmitter is carried aloft by a balloon and tracked automatically by a ground based antenna. Upper level data are provided both

for standard heights above ground and for standard pressure levels. In regions where the ground elevation is near that of the mean sea level, the 500 m height above ground corresponds approximately to the 950 mb (95 kpa) level. Whereas surface measurements are typically made once an hour, radiosonde ascents are normally made only twice a day while pilot balloon ascents are made either twice or four times a day, depending on the station.

Surface data are sensitive to variations of topography, vegetation, the presence of buildings etc., and consequently are often biased by their immediate surroundings. In view of these difficulties, upper level data provide better estimates of the local wind climate. In wind tunnel simulations the wind speed corresponding approximately to the gradient wind is conveniently the free stream speed above the simulated atmospheric boundary layer, which is usually recorded as the experimental reference speed. Unfortunately, gradient wind records are not available for all stations, so that surface anemometer data must at times be relied upon to provide descriptions of the local wind climate.

For some stations, summaries of yearly extreme winds are also available for fairly long periods, say in the order of 60 years. Such data can provide checks on the results of the analysis of the detailed wind speed and direction information discussed above.

PROBABILITY DISTRIBUTION OF MEAN WIND SPEED AND DIRECTION

The relative frequency data of wind speed and wind direction at a particular surface or upper level station can be used to arrive at a description of the probability distribution of wind speed and direction.

The probability of the wind speed V exceeding some value V_1 within an azimuth section of $\alpha_1 \pm \Delta\alpha/2$ can be written as follows:

$$P(V > V_1, \alpha_1 - \frac{\Delta\alpha}{2} < \alpha < \alpha_1 + \frac{\Delta\alpha}{2}) = P(\alpha_1 - \frac{\Delta\alpha}{2} < \alpha < \alpha_1 + \frac{\Delta\alpha}{2}) \times P(V > V_1 | \alpha_1 - \frac{\Delta\alpha}{2} < \alpha < \alpha_1 = \frac{\Delta\alpha}{2}) \tag{A.2}$$

The first term on the right hand side is the marginal probability of the wind direction being within the azimuth sector $\alpha_1 \pm \Delta\alpha/2$, regardless of the wind speed; the second term is the probability of exceeding a wind speed V_1, conditional upon the wind direction being within that sector.

It is convenient to fit the joint probability of wind speed and direction given in equation A.2 by a mathematical model. The conditional probability above can be fitted by a Weibull distribution of the following form:

$$P(V > V_1 | \alpha_1 \pm \frac{\Delta\alpha}{2}) = e^{-\{V_1/C(\alpha_1)\}^{K(\alpha_1)}} \tag{A.3}$$

where $K(\alpha_i)$ and $C(\alpha_i)$ are the Weibull coefficients pertaining to the sector defined by $\alpha_i \pm \Delta\alpha/2$. Although other mathematical models have been used to describe the probability distribution of wind speed and direction (A-3, A-8, A-9), the simplicity of the Weibull distribution offers practical advantages. The applicability of the Weibull model has been confirmed for a large number of upper level and surface stations. The marginal probability of the wind direction being within a particular sector is the relative frequency of occurrence of all wind speeds within that sector. Wind records are usually divided into sixteen compass directions and consequently $\Delta\alpha = 22.5^o$.

Denoting the relative frequency of occurrence of all wind speeds within a sector $\alpha \pm \Delta\alpha/2$ by $A(\alpha)$, the probability of exceeding a wind speed V, from wind directions within an azimuth sector of $\alpha \pm \Delta\alpha/2$, can be written as:

$$P(>V,\theta) = A(\alpha)\, e^{-\{V/C(\alpha)\}^{K(\alpha)}} \tag{A.4}$$

From the definition of $A(\alpha)$ it follows that $\sum_{all\ sectors} A(\alpha) = 1$. The parameters $A(\alpha), C(\alpha)$, and $K(\alpha)$, can be evaluated from the relative frequency records of surface or upper level wind speeds provided for the standard sixteen compass directions. These can then be approximated by finite term Fourier series to provide continuous mathematical expressions for the Weibull coefficients. Namely,

$$A(\alpha) = A_o + \sum_{n=1}^{M} (A'_n \cos n\alpha + A_n \sin n\alpha)$$

$$C(\alpha) = C_o + \sum_{n=1}^{M} (C'_n \cos n\alpha + C_n \sin n\alpha) \tag{A.5}$$

$$K(\alpha) = K_o + \sum_{n=1}^{M} (C'_n \cos n\alpha + K_n \sin n\alpha)$$

where M is the number of terms used in the Fourier series fit and $A_o, A_n, A'_n, C_o, C_n, C'_n, K_o, K_n$ and K'_n are the Fourier series coefficients. A value of $M = 4$ is generally found to give a satisfactory fit to the Weibull parameters.

The marginal probability of exceeding a particular wind speed, namely the probability of exceeding that wind speed from any wind direction, is obtained from equation A.4 as follows:

$$P(>V) = \sum_{all\ sectors} A(\alpha)\, e^{-\{V/C(\alpha)\}^{K(\alpha)}} \tag{A.6}$$

Alternatively the probability distribution of wind speed regardless of wind direction can be obtained by directly fitting the marginal histogram of wind speed (arrived at by summing the histograms for all compass directions) with a Weibull distribution. The K parameter of this distribution is generally of the order of 2, suggesting that the marginal distribution of wind speed is similar to a Rayleigh distribution.

Probability distributions of wind speed and direction can be obtained on a monthly, seasonal or annual basis.

The above model can be used to obtain either surface or upper level descriptions of the wind climate. In the absence of actual upper level data, the probability distribution of gradient wind speed and direction can be estimated from the Weibull model derived from surface anemometer records. Based on equation A.1, this can be done by directly adjusting the Weibull parameter C,

$$C_g(\alpha) = b(\alpha)C_s(\alpha) \tag{A.7}$$

where C_g and C_s are the respective Weibull parameters for gradient and surface wind speeds.

For an anemometer located in approximately homogeneous terrain, b can be assumed to be independent of wind direction and is given by:

$$b = \left(\frac{z_g}{z_s}\right)^m$$

where z_s is the height at which the surface measurements were made.

APPLICABILITY OF THE WIND CLIMATE MODEL

The reliability of the wind model obtained as outlined above depends largely on the length of data record available and the type of storms that frequent a given region. Typically wind records range from 10 to 25 years. This is generally found sufficient to provide good estimates of extreme events for wind climates dominated by the effects of extratropical cyclones, i.e., the low pressure systems commonly seen on weather charts (A-10), because these generally affect very extensive areas and occur quite frequently.

In regions where physically smaller and less frequent storms contribute significantly to the wind climate, available wind records may not be sufficient. Such regions would include, for example, those frequented by tornadoes or by tropical cyclones. The severest of the latter are commonly termed hurricanes. Along the Gulf Coast and Florida Penninsula in the U.S., severe tropical cyclones dominate the climate of strong winds. Along the New England Coast such storms contribute to the wind climate but to a much lesser extent than along the Gulf Coast. Because of the rarity of these storms and their relatively small size, a typical twenty year record is not

sufficient to obtain a reliable statistical estimate. Furthermore, there is the difficulty that instruments often fail in hurricane force winds. Similar comments can be made regarding the contribution to the wind climate by tornado-generating thunderstorms in the mid-western U.S.A.

A different approach based on computer simulations of events such as tropical cyclones can lead to more reliable statistical predictions of building response. Such an approach has been used by the Boundary Layer Wind Tunnel Laboratory on several occasions and is described in detail in reference (A-11).

The reliability of the wind model can also be affected by severe topography in two ways. Large hills or mountains can severely distort surface wind measurements, and can essentially increase the height at which gradient conditions are first approximated. Futhermore, severe winds can originate in regions near mountain ranges due to thermal instabilities in the atmosphere. These downslope winds are referred to by several names such as Santa Anna winds, chinooks, etc. and are particularly prevalent in West coast areas and areas just east of the Rocky Mountains. Their detailed structure is not well understood, particularly in regions close to the mountains where significant vertical flows can occur, leading to severe spatial inhomogeneities near the ground. Away from the close proximity of the mountains, the flows appear to take on the characteristics of "normal" storm winds, although little information exists on the boundary layer structure away from the surface.

In areas affected by such winds, conservative modelling of the approaching flows is the current state-of-the-art.

REFERENCES

A-1 Sutton, O. G., "Micrometeorology", McGraw-Hill Book Co., 1953.

A-2 Davenport, A. G., "The Relationship of Wind Structure to Wind Loading", Symposium on Wind Effects on Buildings and Structures, Teddington, 1973.

A-3 Davenport, A. G., "The Dependence of Wind Loads on Meteorological Parameters", Proc. Intnl. Seminar on Wind Effects on Bldgs. and Structures, Ottawa, 1967.

A-4 McNamara, K. F., "Characteristics of the Mean Wind Flow in the Planetary Boundary Layer and Its Effects on Tall Towers", Ph.D. Thesis, Univ. of Western Ontario, 1975.

A-5 Davenport, A. G. and Isyumov, N., "The Application of the Boundary Layer Wind Tunnel to the Prediction of Wind Loading", Proc. Intnl. Sem. on Wind Effects on Bldgs. and Structures, Ottawa, 1967.

A-6 Van Der Hoven, I., "Power Spectrum of Horizontal Wind Speed in the Frequency Range From 0.007 to 900 Cycles Per Hour", Jnl. Met., Vol. 14, 1957.

A-7 Lumley, J. L. and Panofsky, H. A., "The Structure of Atmospheric Turbulence", Interscience Publishers, John Wiley & Sons, 1964.

A-8 Davenport, A. G., Isyumov, N. and Jandali, T., "A Study of Wind Effects for the Sears Project", Univ. of Western Ontario, Engineering Science Research Report, BLWT-5-71, 1971.

A-9 Baynes, C. J., "The Statistics of Strong Winds for Engineering Applications", Ph.D. Thesis, Univ. of Western Ontario, Engineering Science Research Report, BLWT-4-74, 1974.

A-10 Gomes, L. and Vickery, B. J., "On the Predictions of Extreme Wind Speeds From the Parent Distribution", Research Report No. R241, University of Sydney, March 1974.

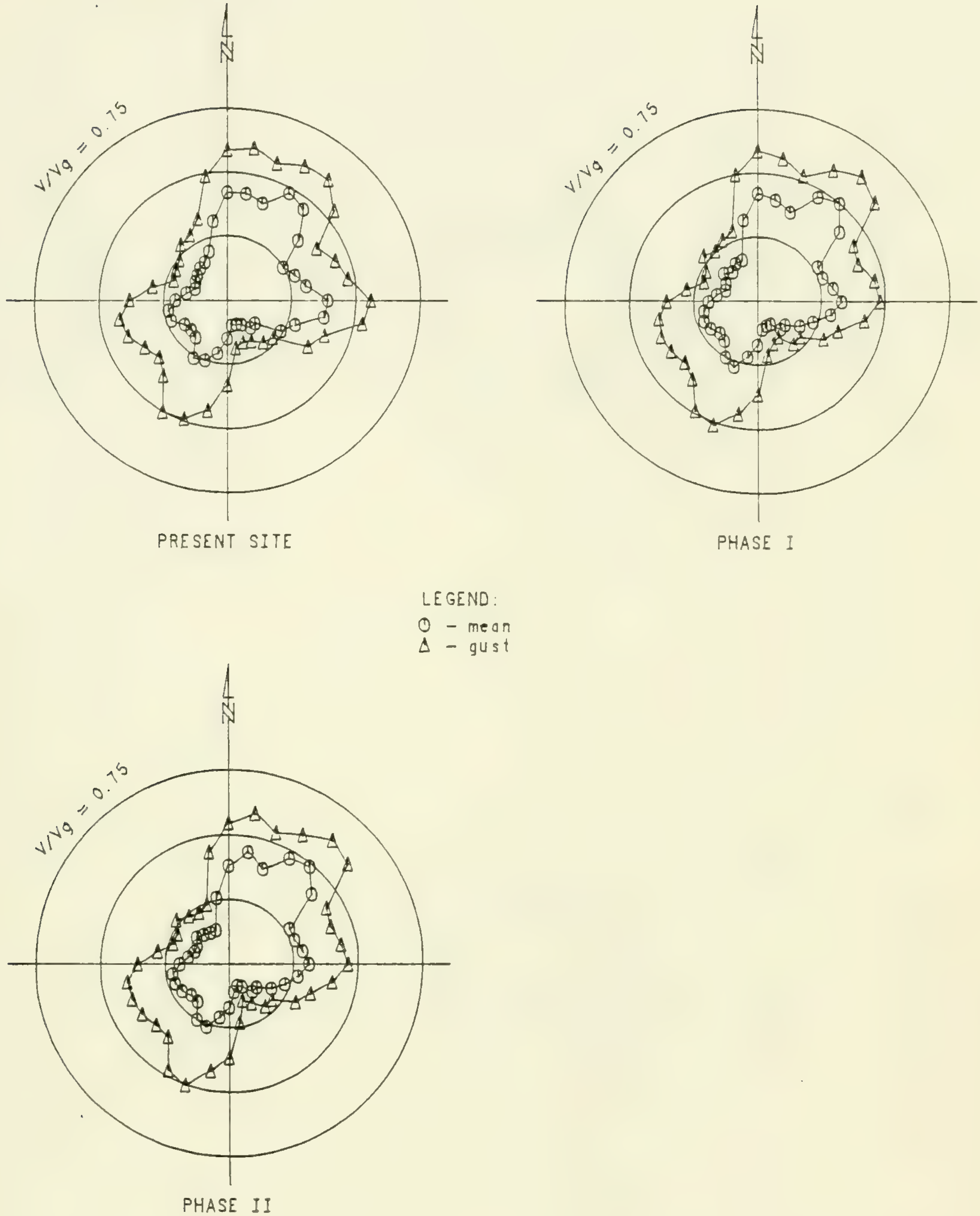
A-11 Tryggvason, B. V., Surry, D. and Davenport, A. G., "Predicting Wind-Induced Response in Hurricane Zones", Journal of the Structural Division, ASCE, Vol. 102, No. ST12, Proc. Paper 12630, December 1976, pp. 2333-2350.

SECTION B-3

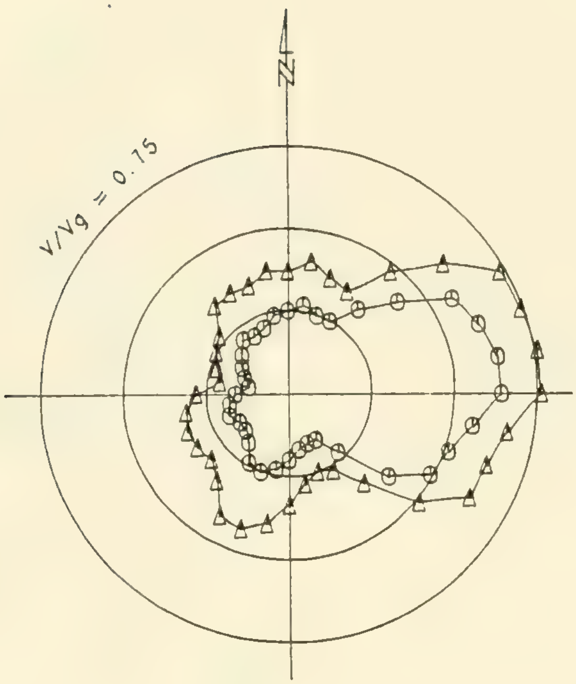
POLAR PLOTS OF MEAN AND GUST WIND SPEEDS

POLAR PLOTS OF MEAN AND GUST WIND SPEEDS

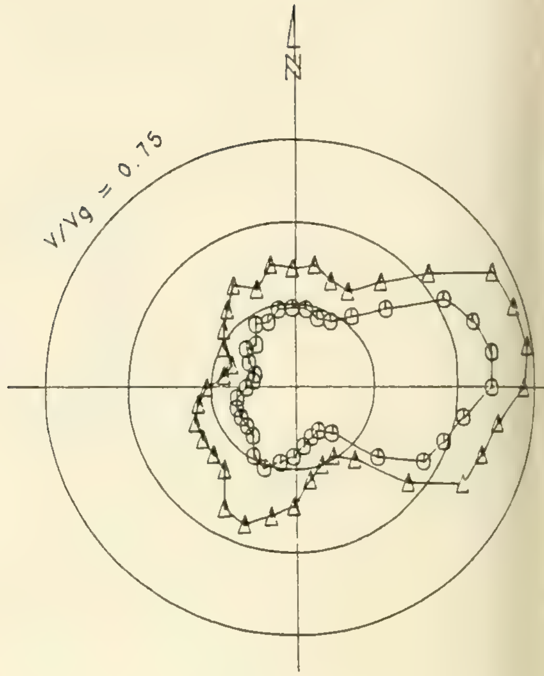
Note: For each gradient wind direction, the plots represent the fraction of the gradient wind speed expected at ground level. Each plot shows both the mean speed and an effective gust speed, defined as gust = mean + 1.5 RMS. This particular definition leads to a gust speed to which humans are expected to be sensitive. Further background for its definition canbe found in Ref. 5.



WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 1

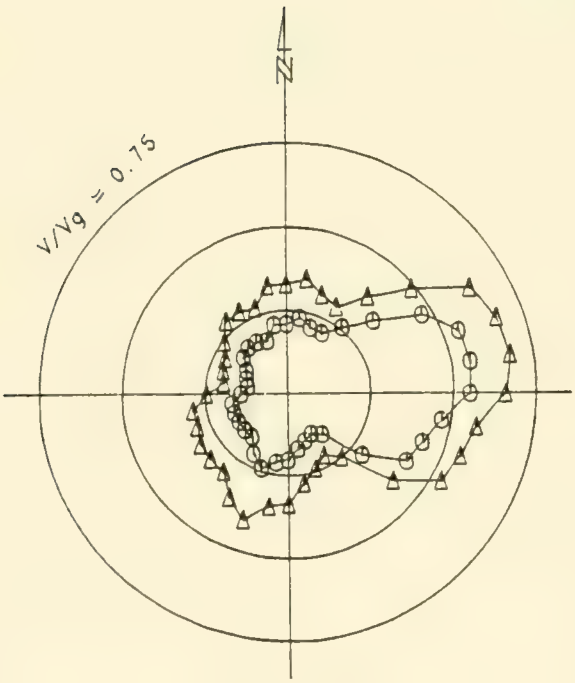


PRESENT SITE



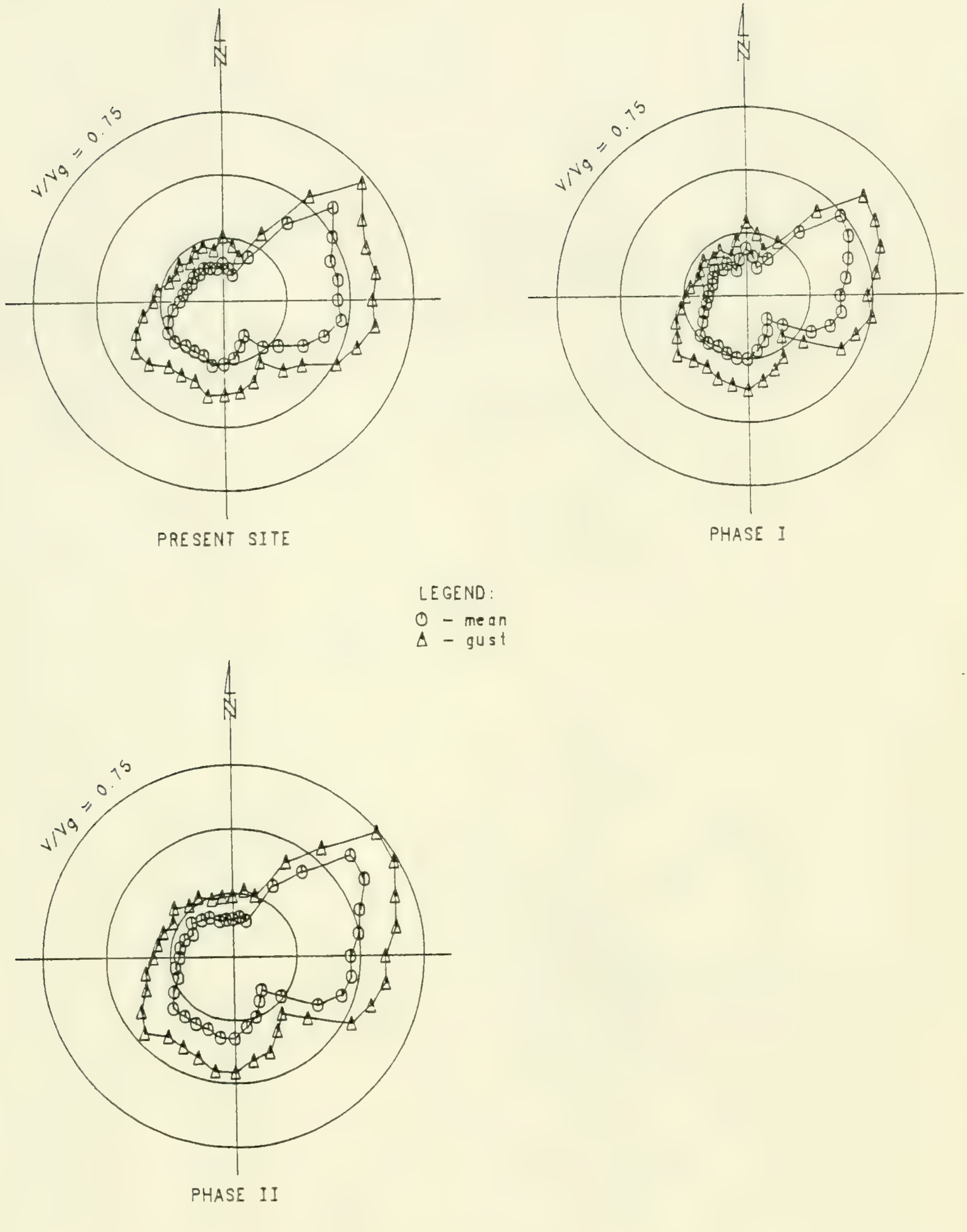
PHASE I

LEGEND:
O – mean
Δ – gust

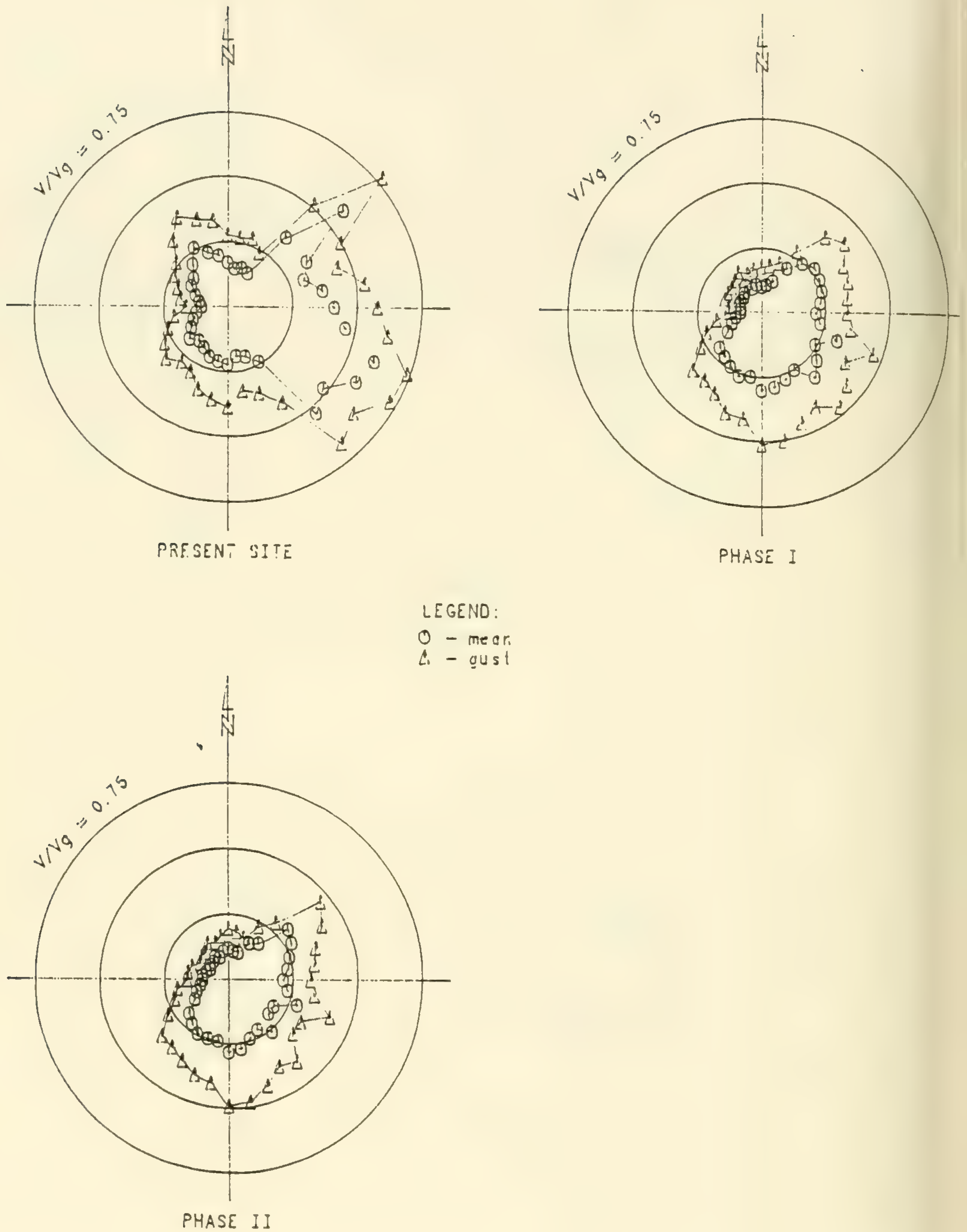


PHASE II

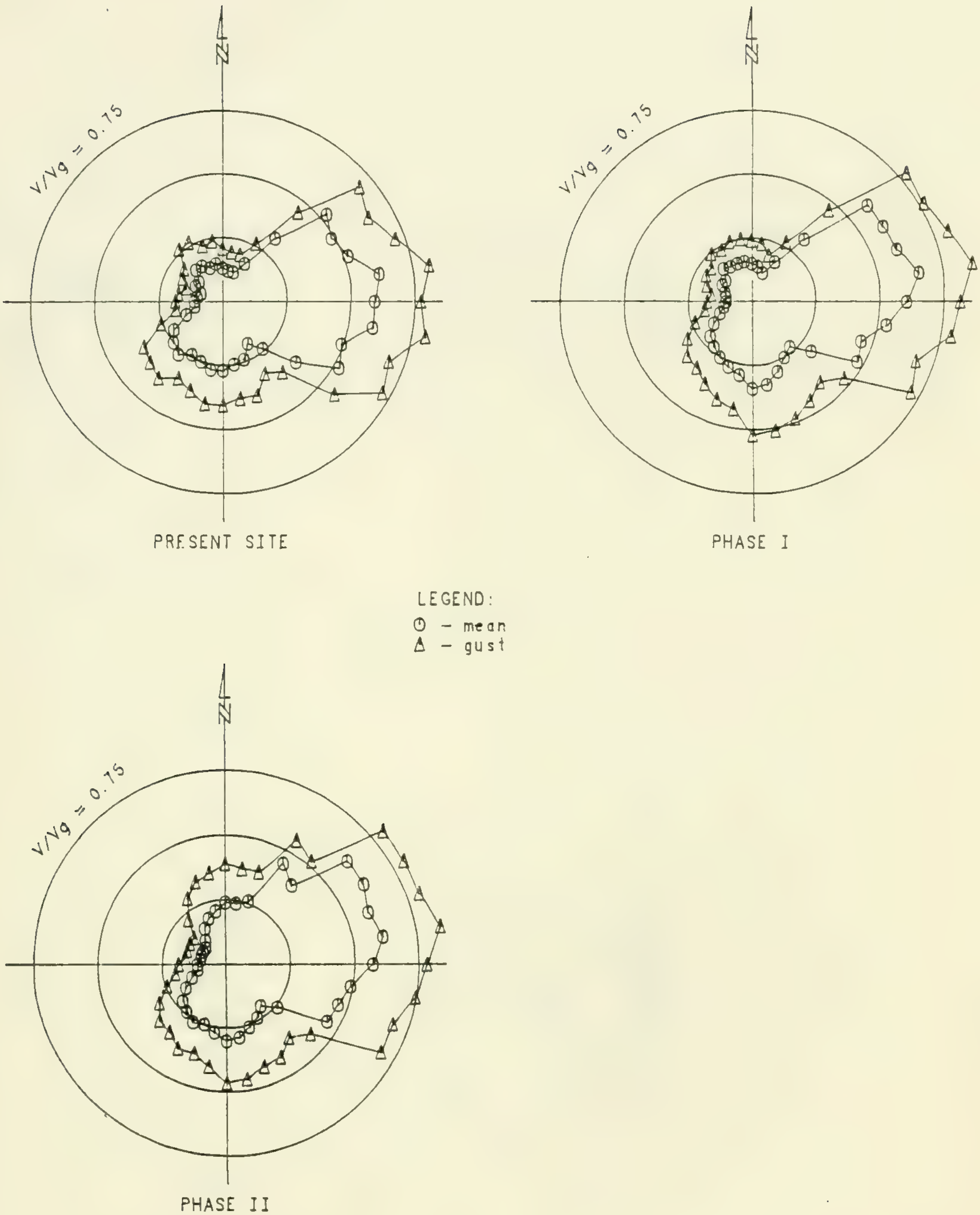
WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 2



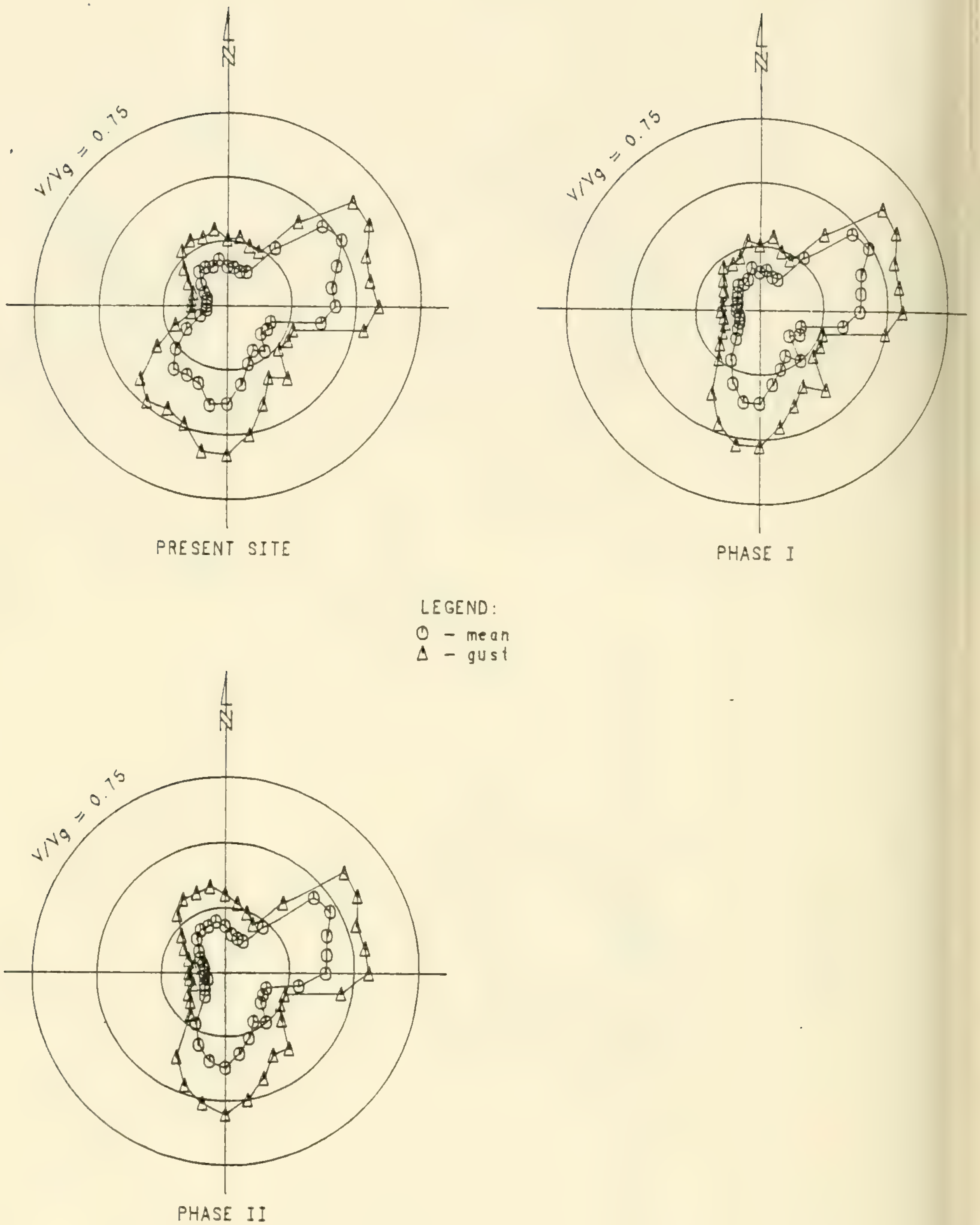
WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 3



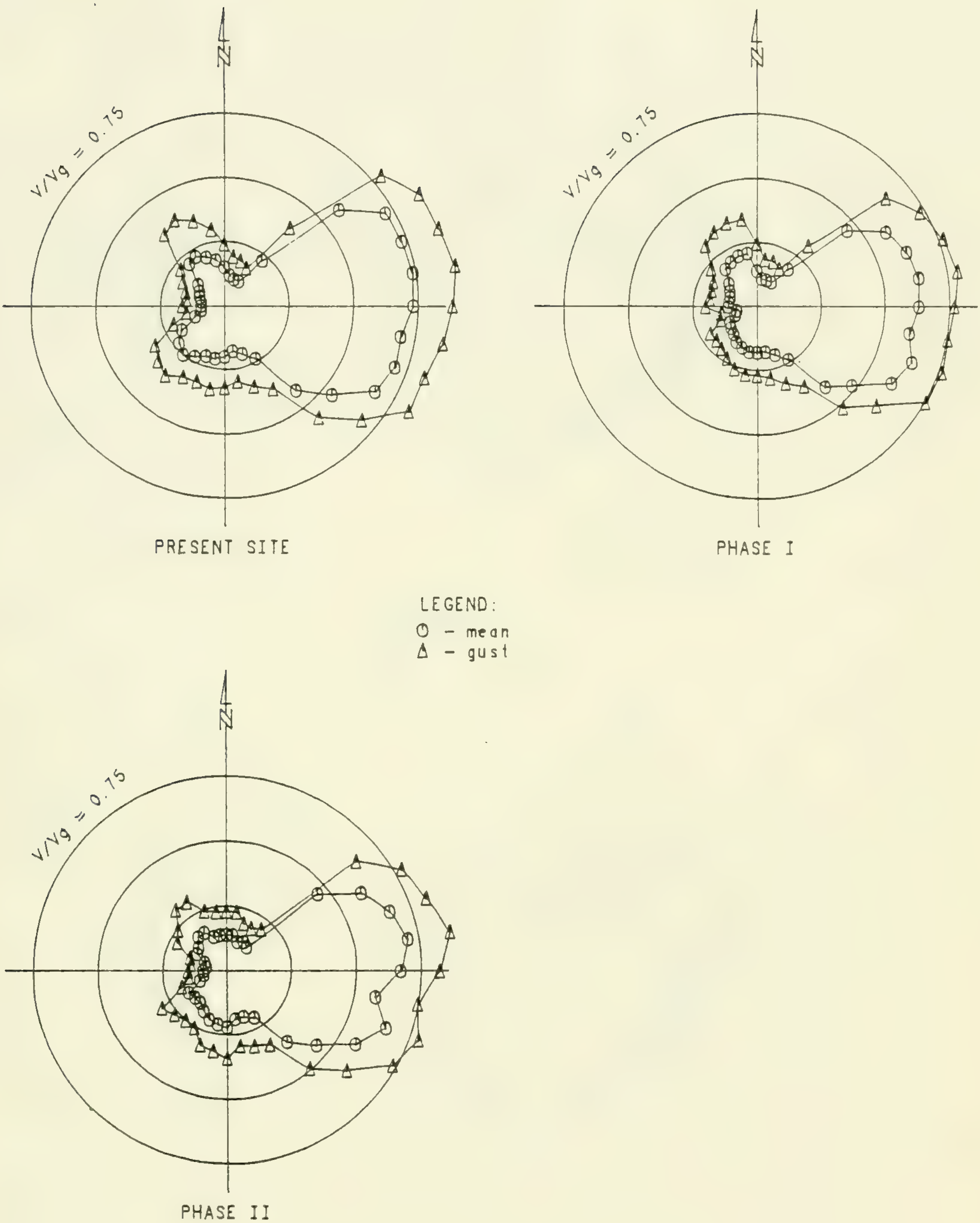
WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 4



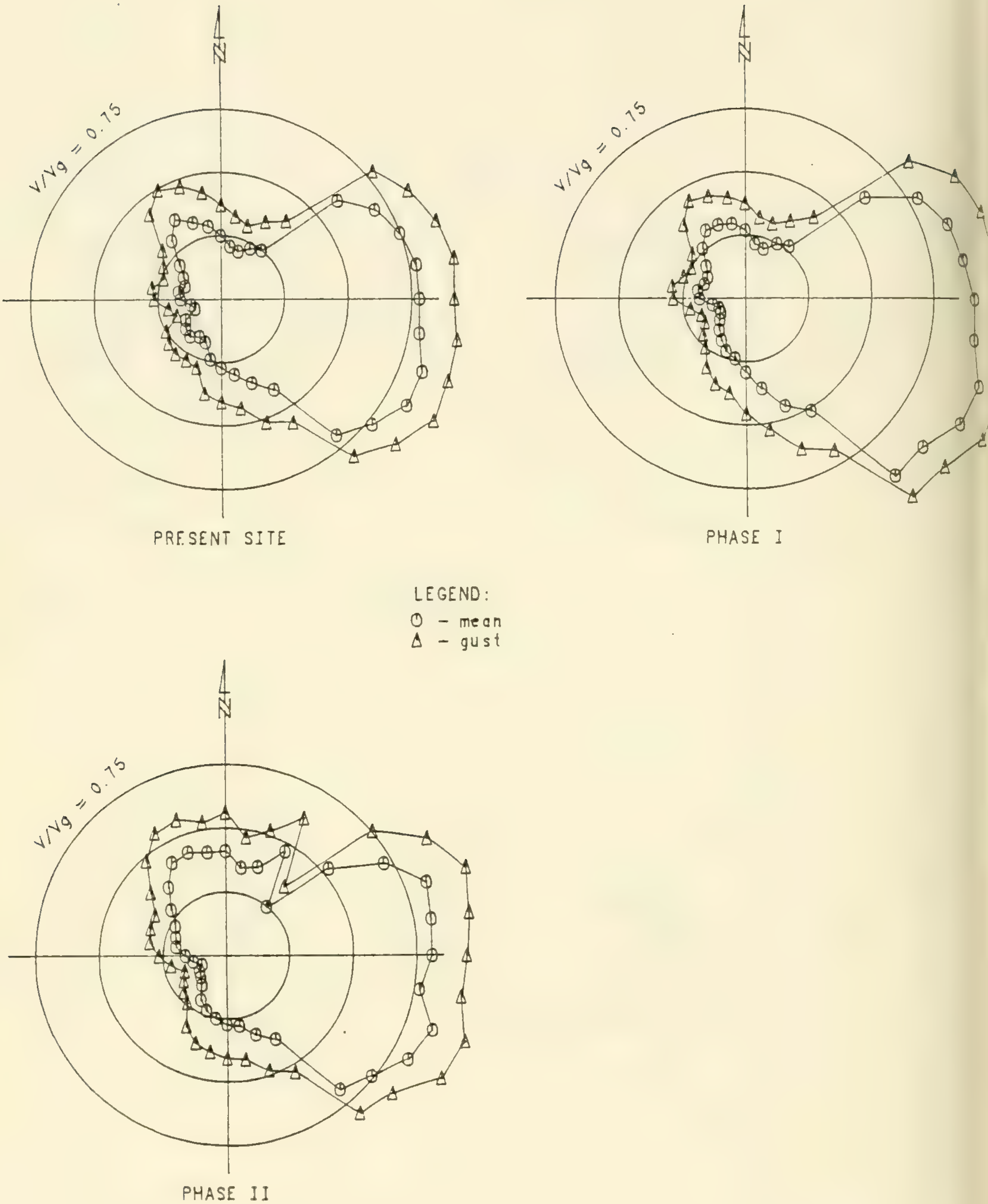
WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 5



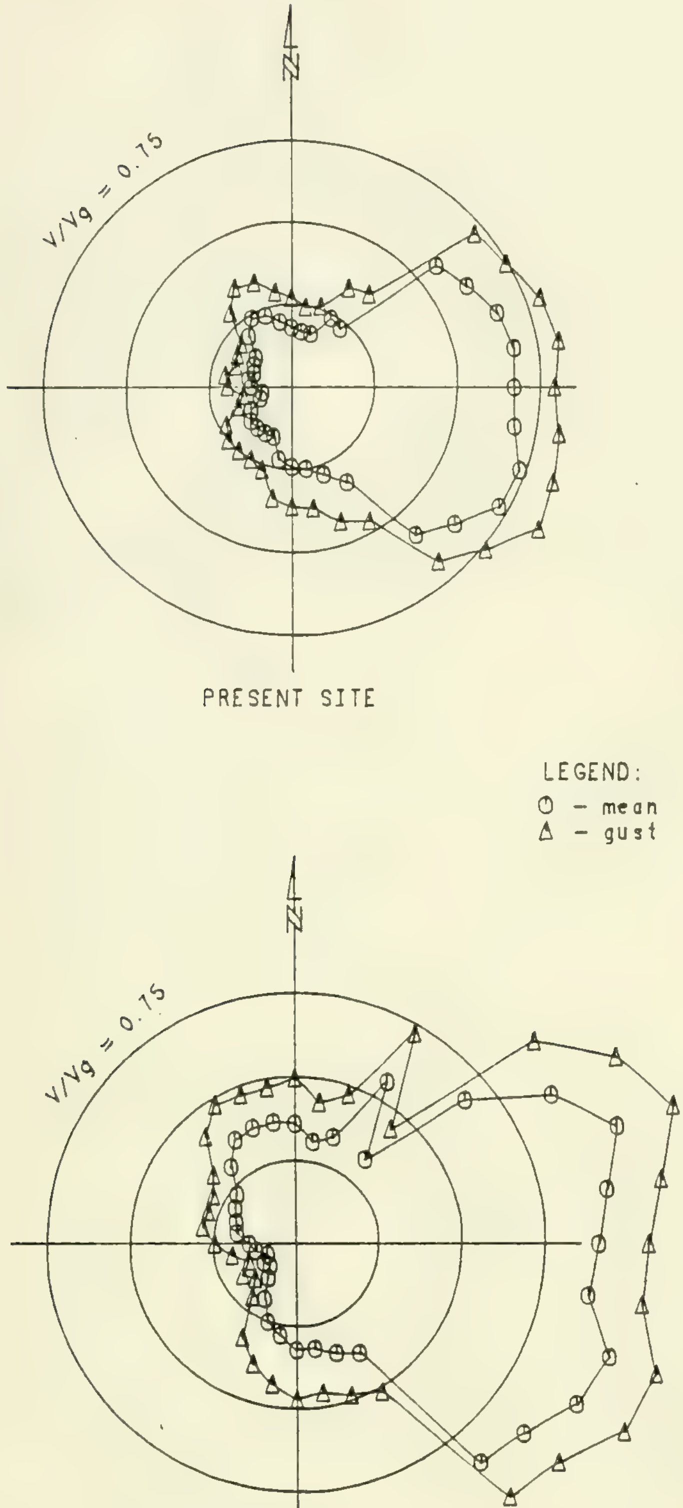
WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 6



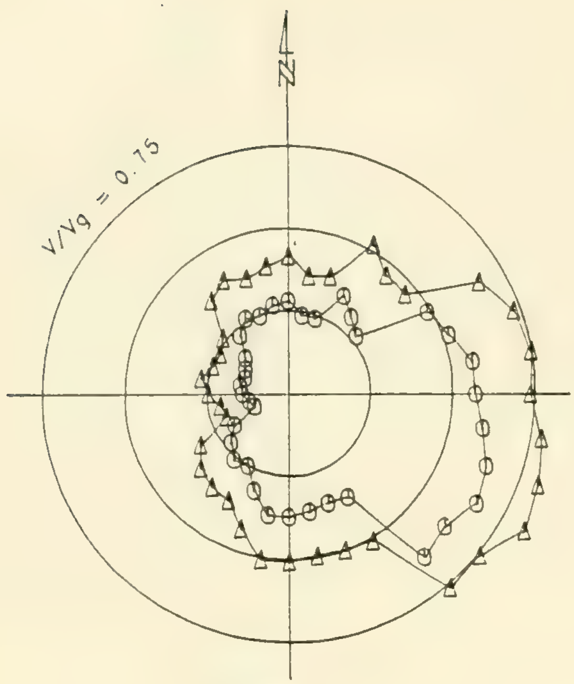
WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 7



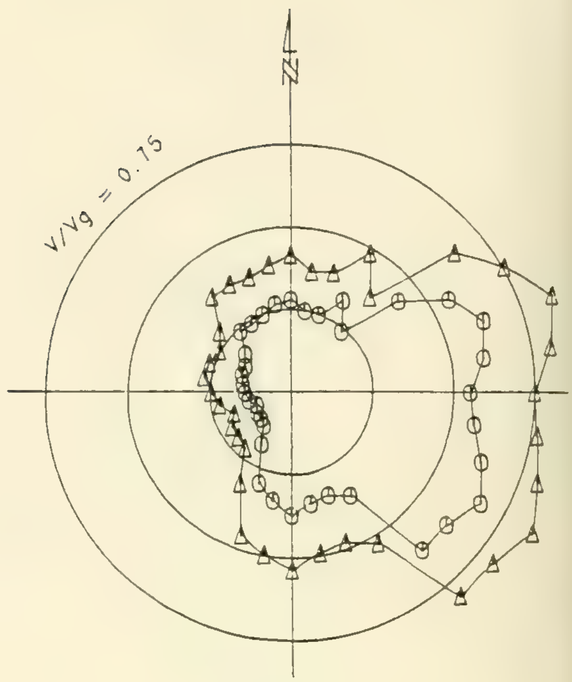
WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 8



WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 9

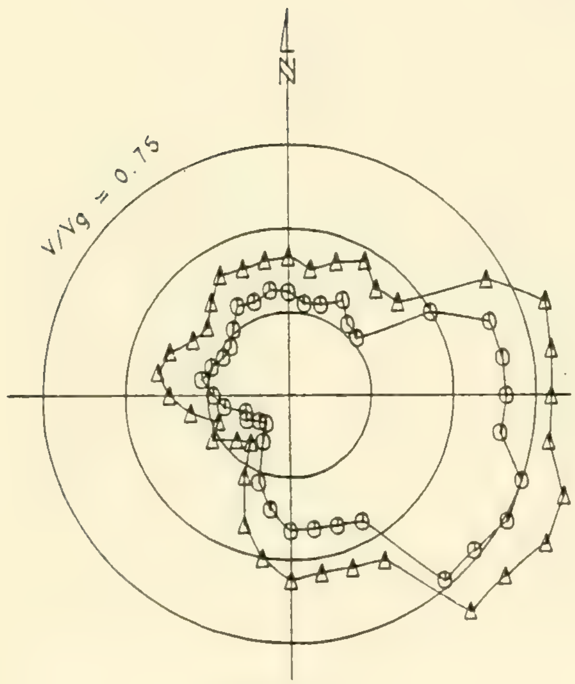


PRESENT SITE



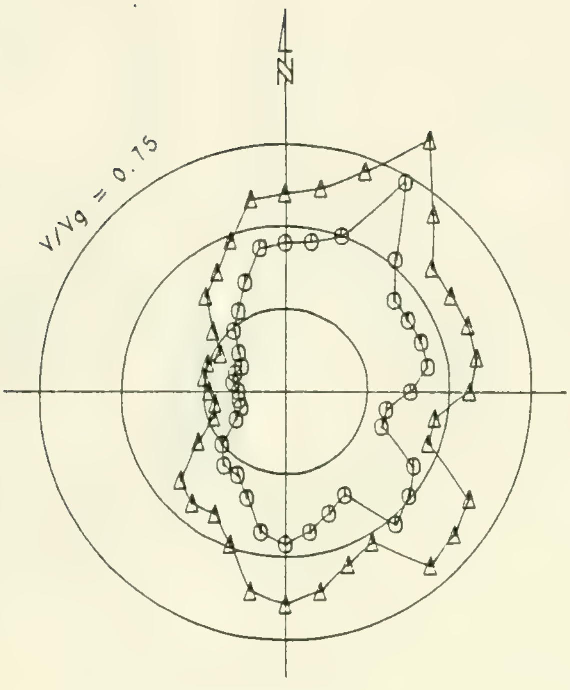
PHASE I

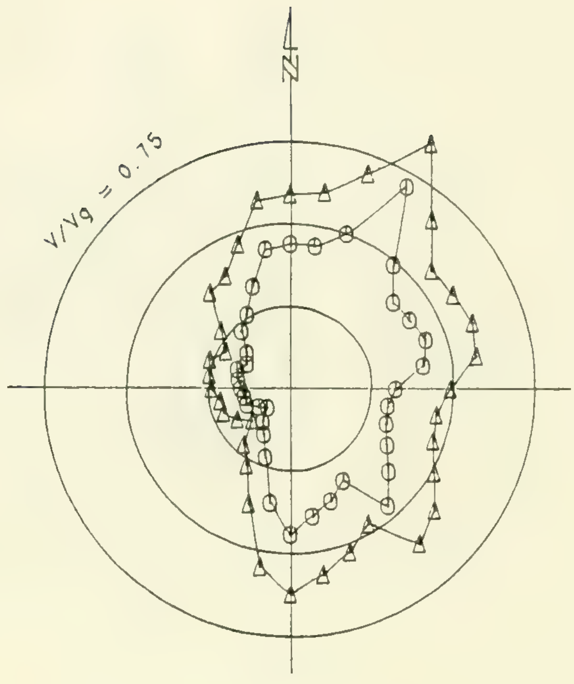
LEGEND:
⊖ - mean
Δ - gust



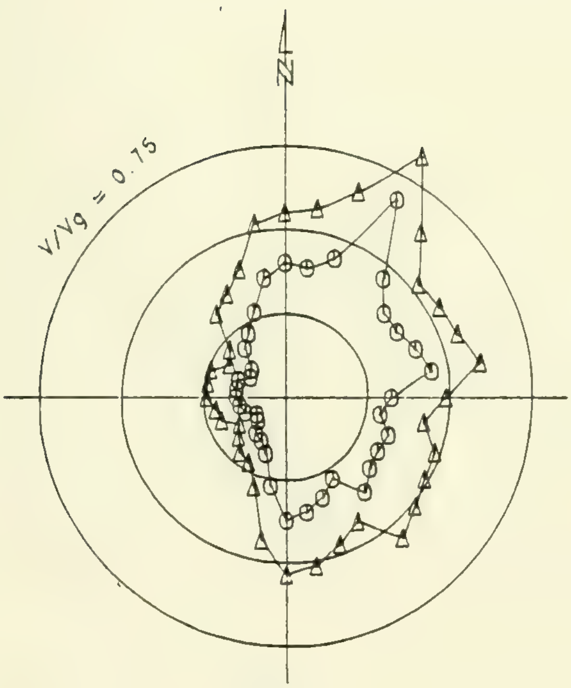
PHASE II

WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 10

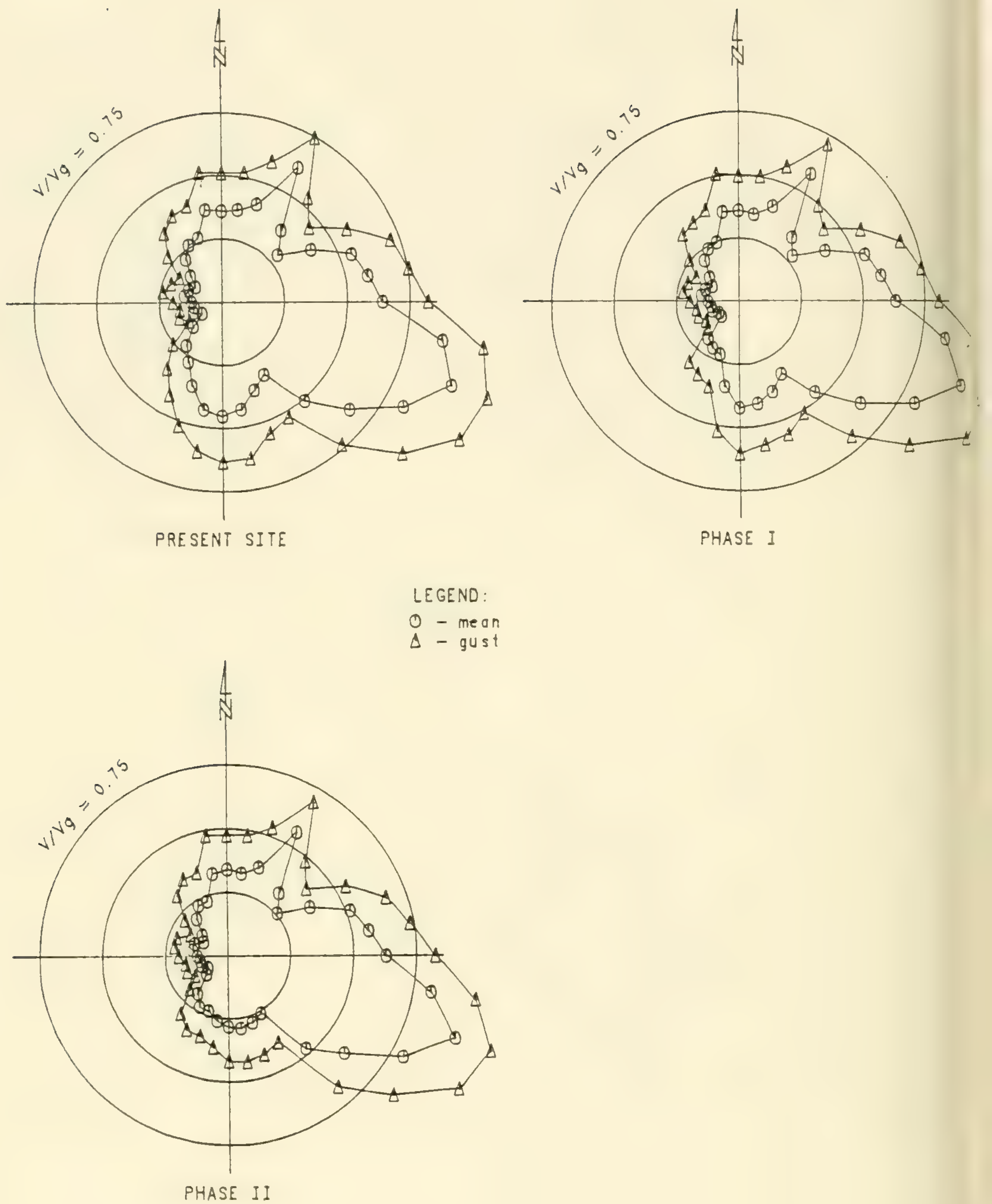




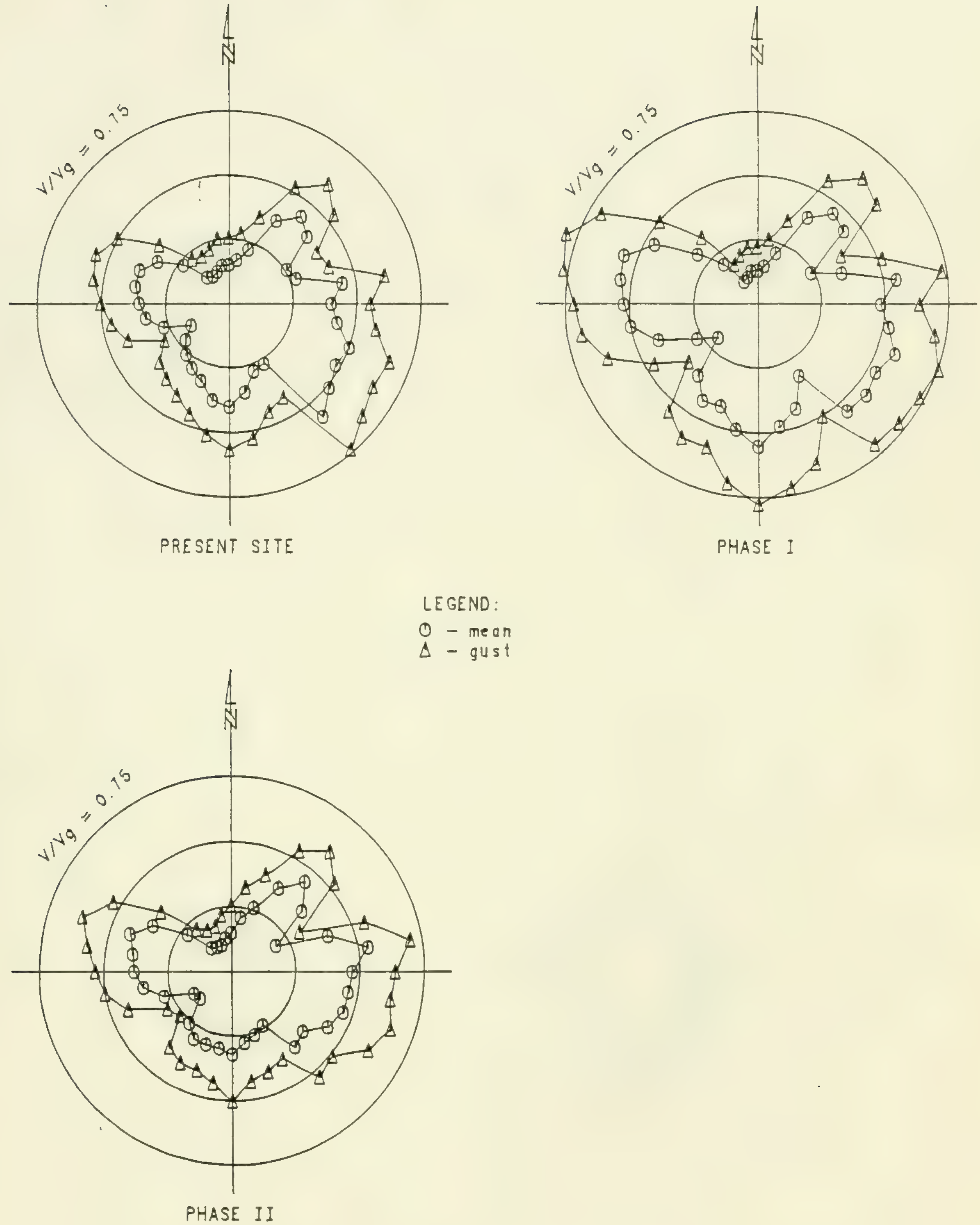
LEGEND:
O - mean
Δ - gust



WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 11

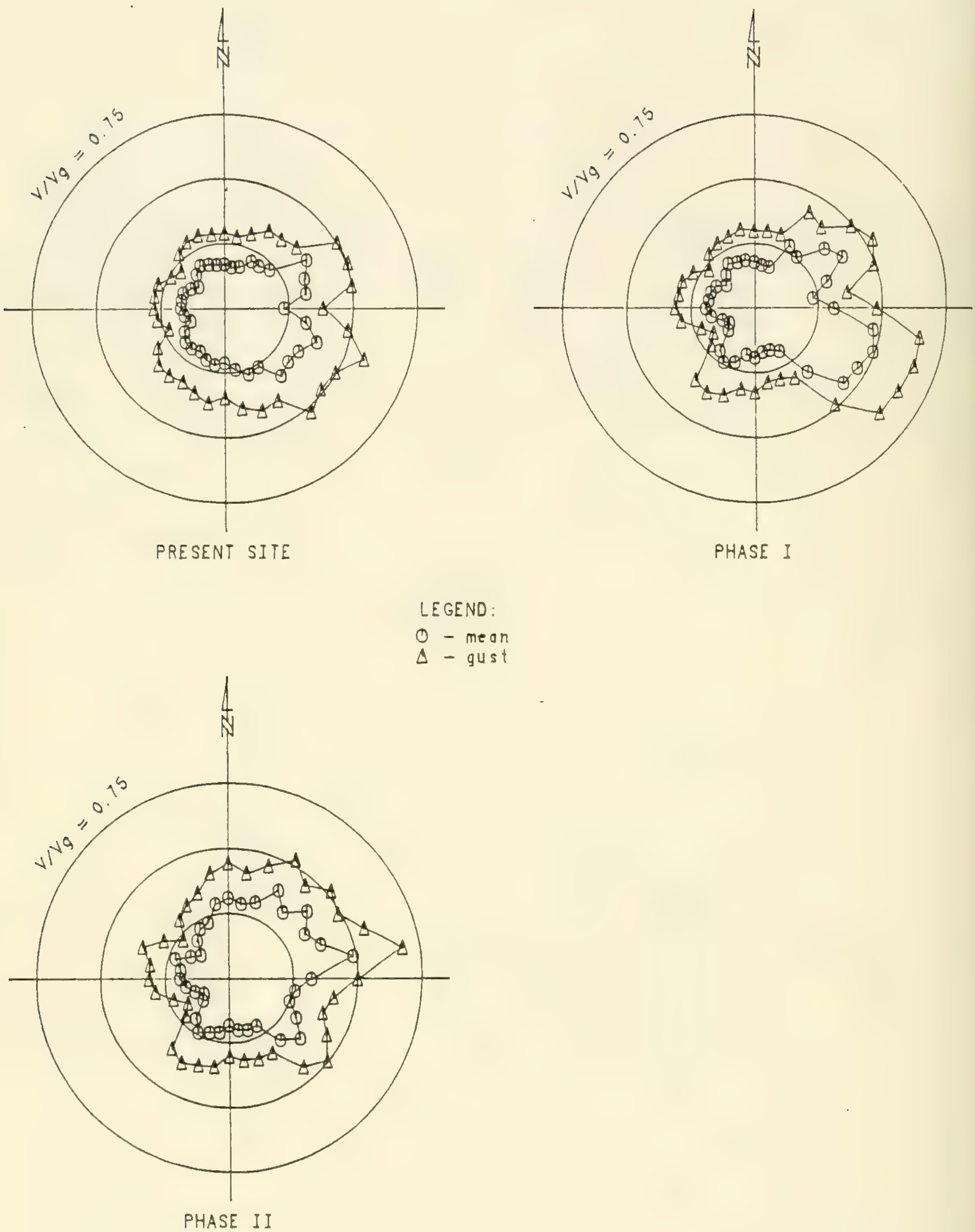


WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 12

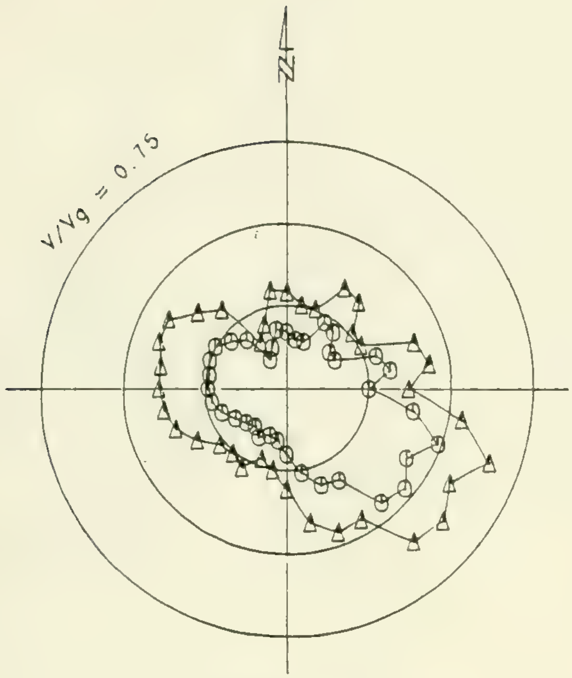


WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS

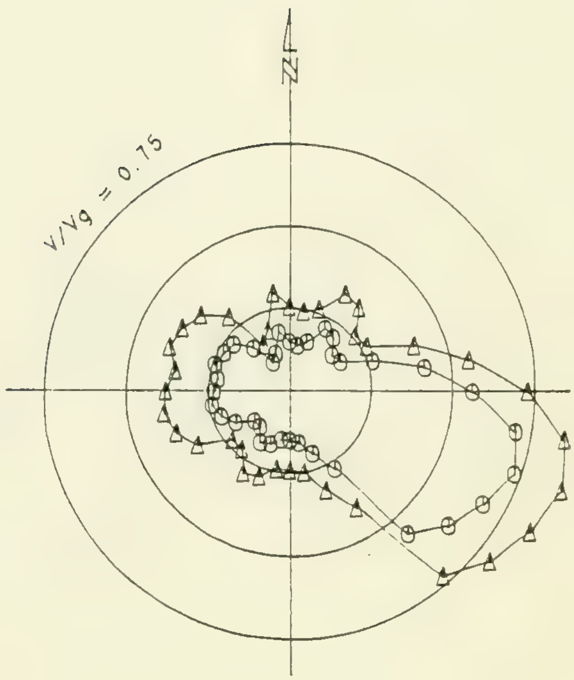
PROBE LOCATION 13



WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 14

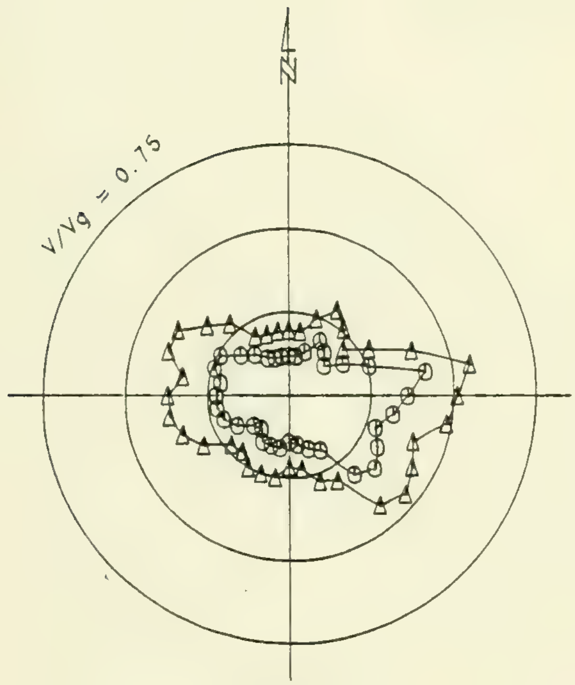


PRESENT SITE



PHASE I

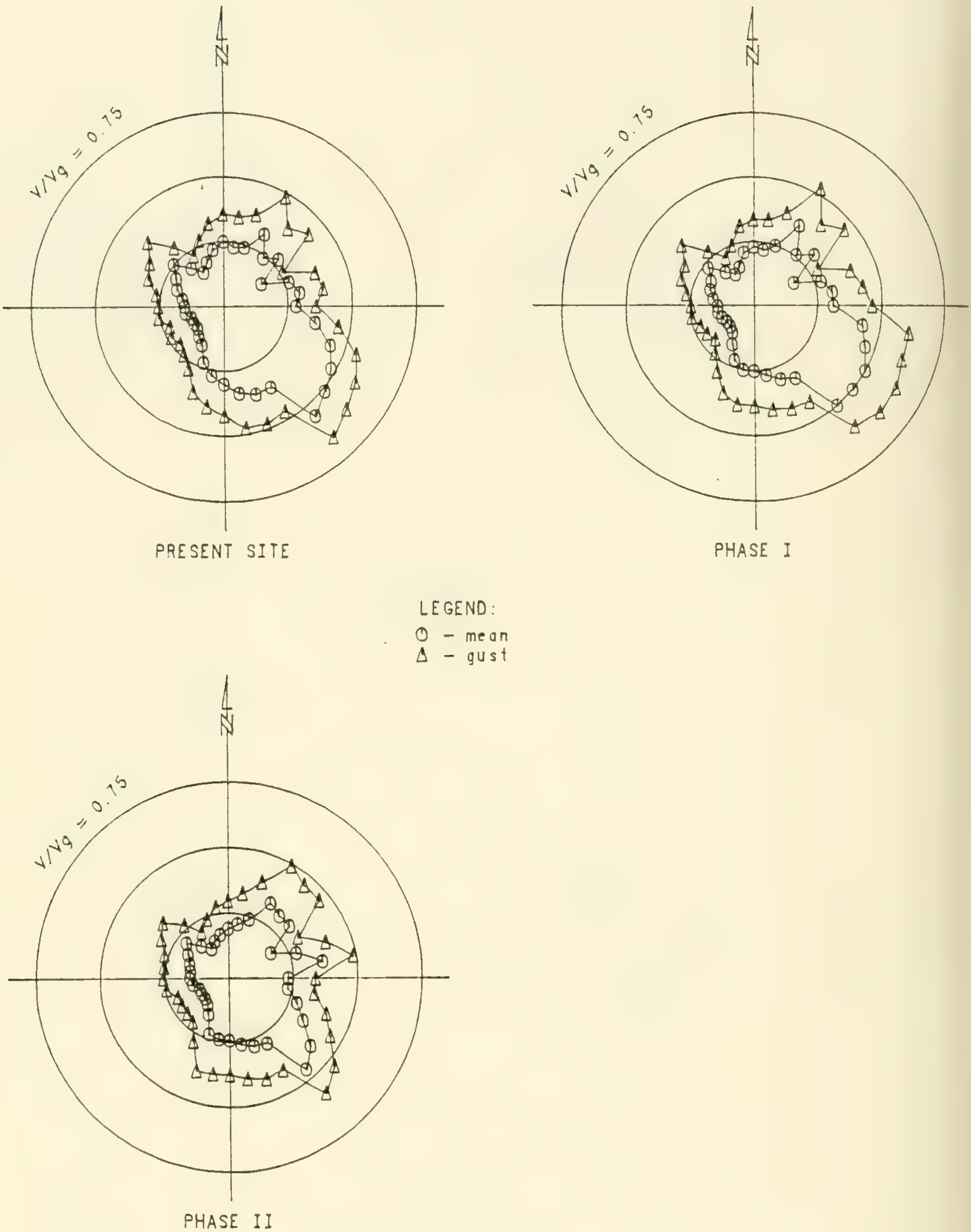
LEGEND:
O - mean
Δ - gust



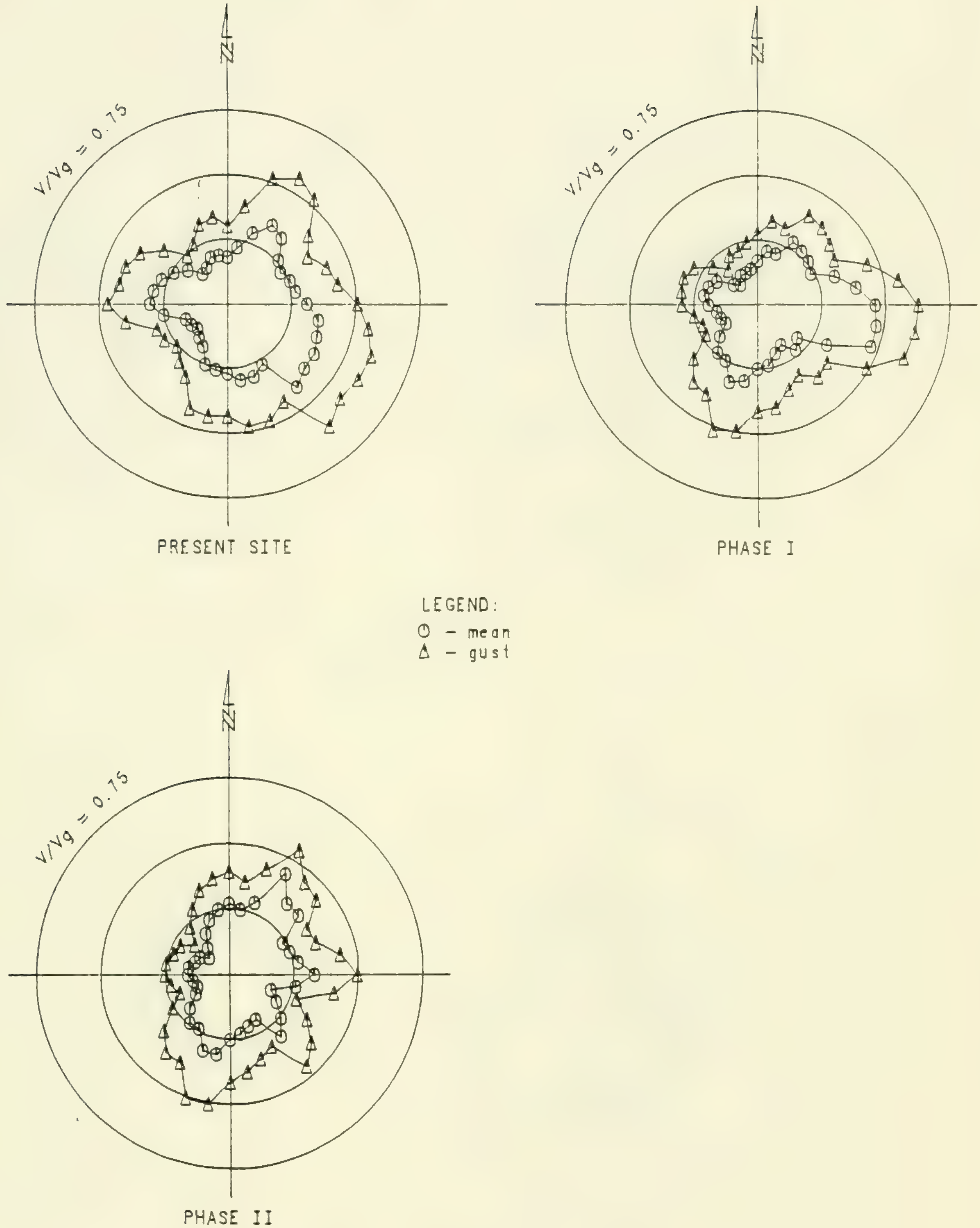
PHASE II

WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS

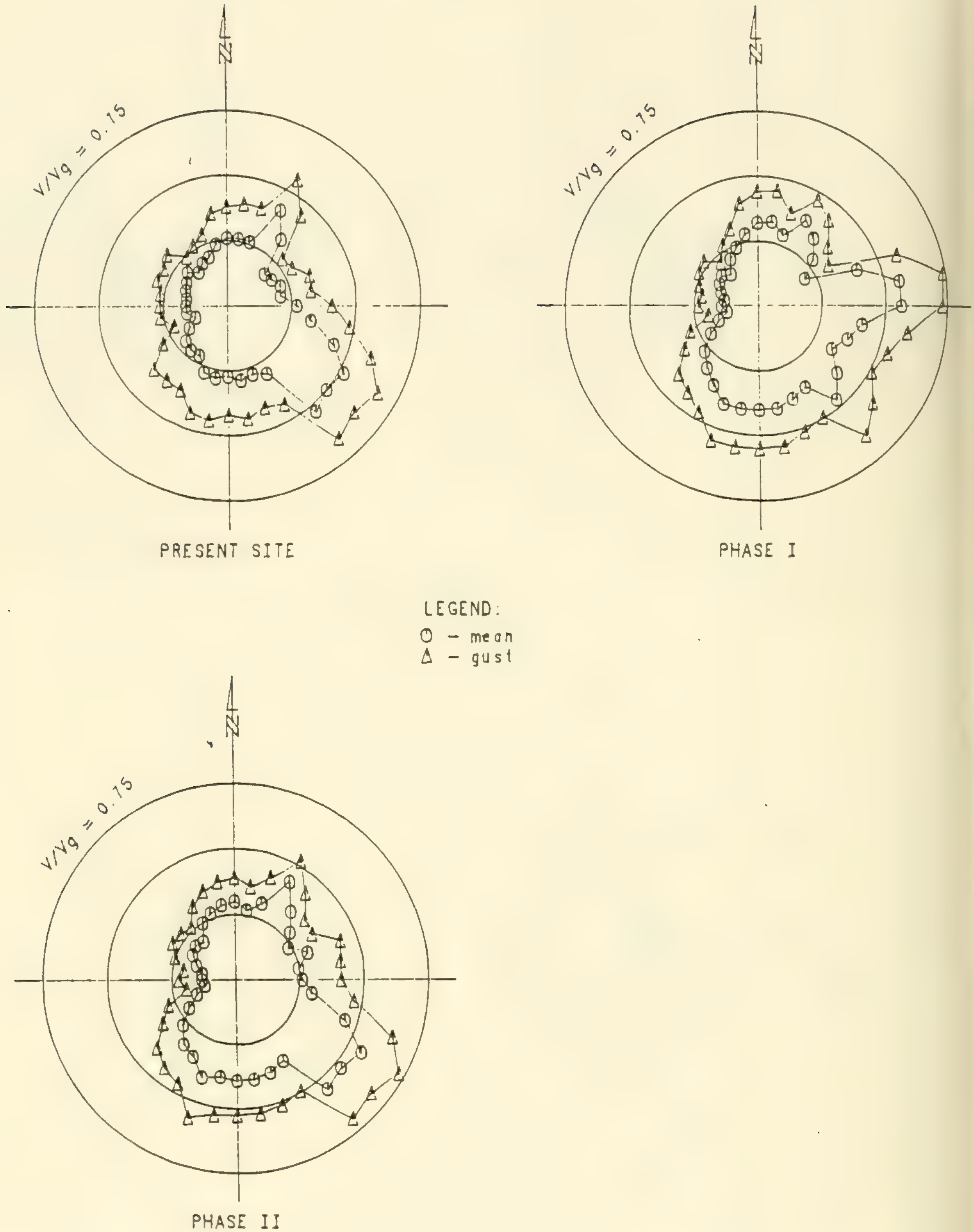
PROBE LOCATION 15



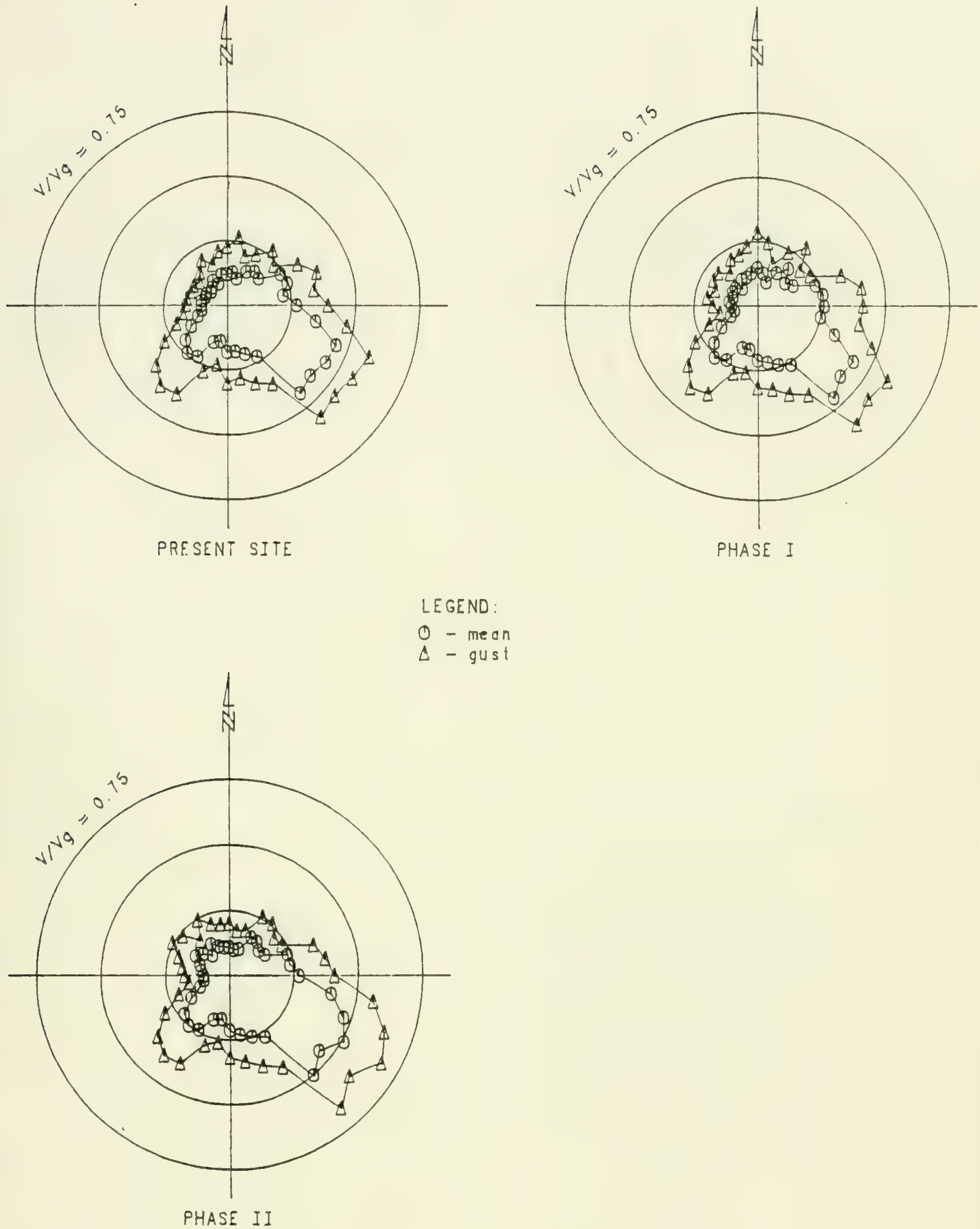
WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 16



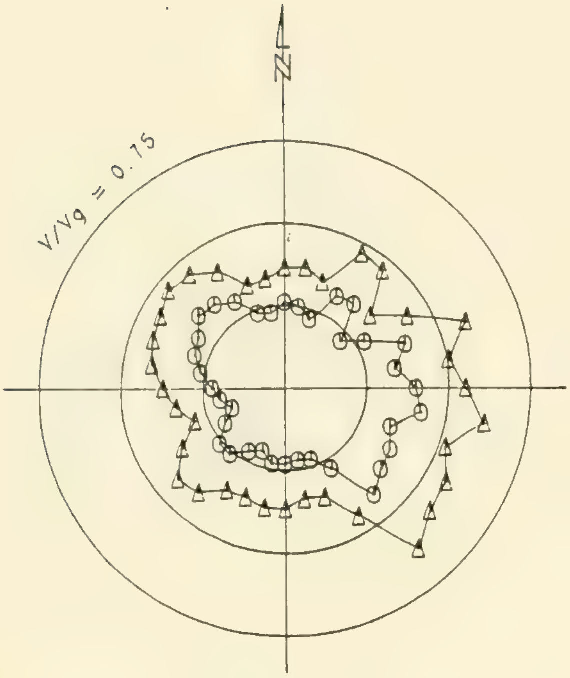
WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 17



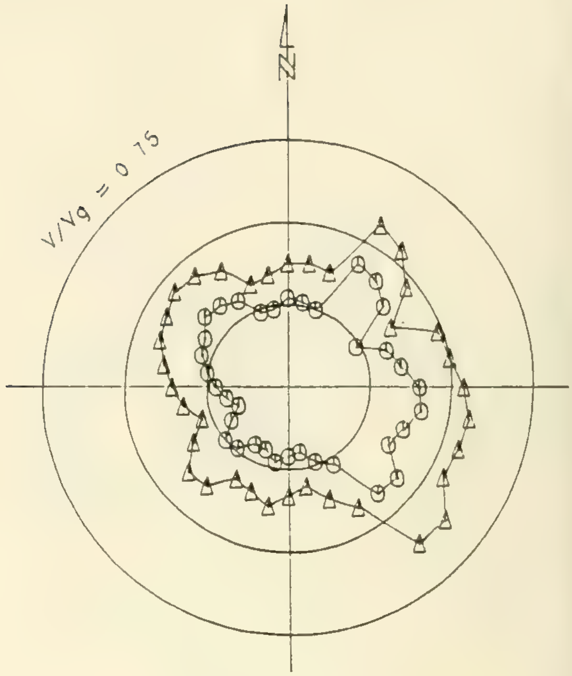
WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 18



WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 19

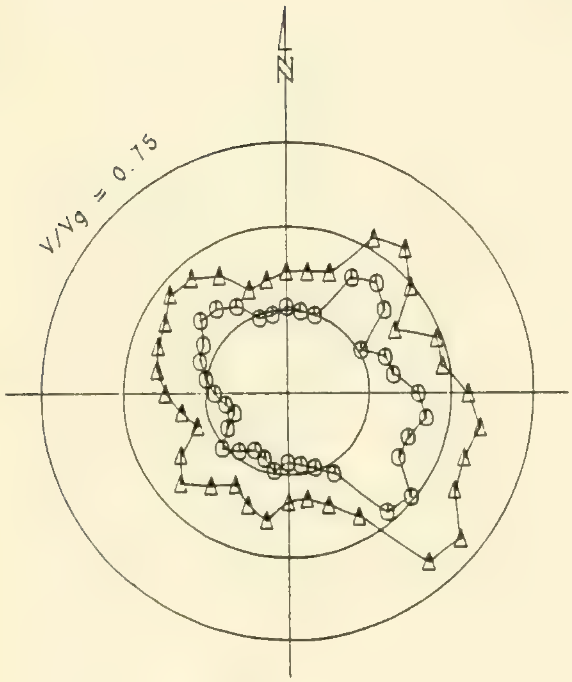


PRESENT SITE



PHASE I

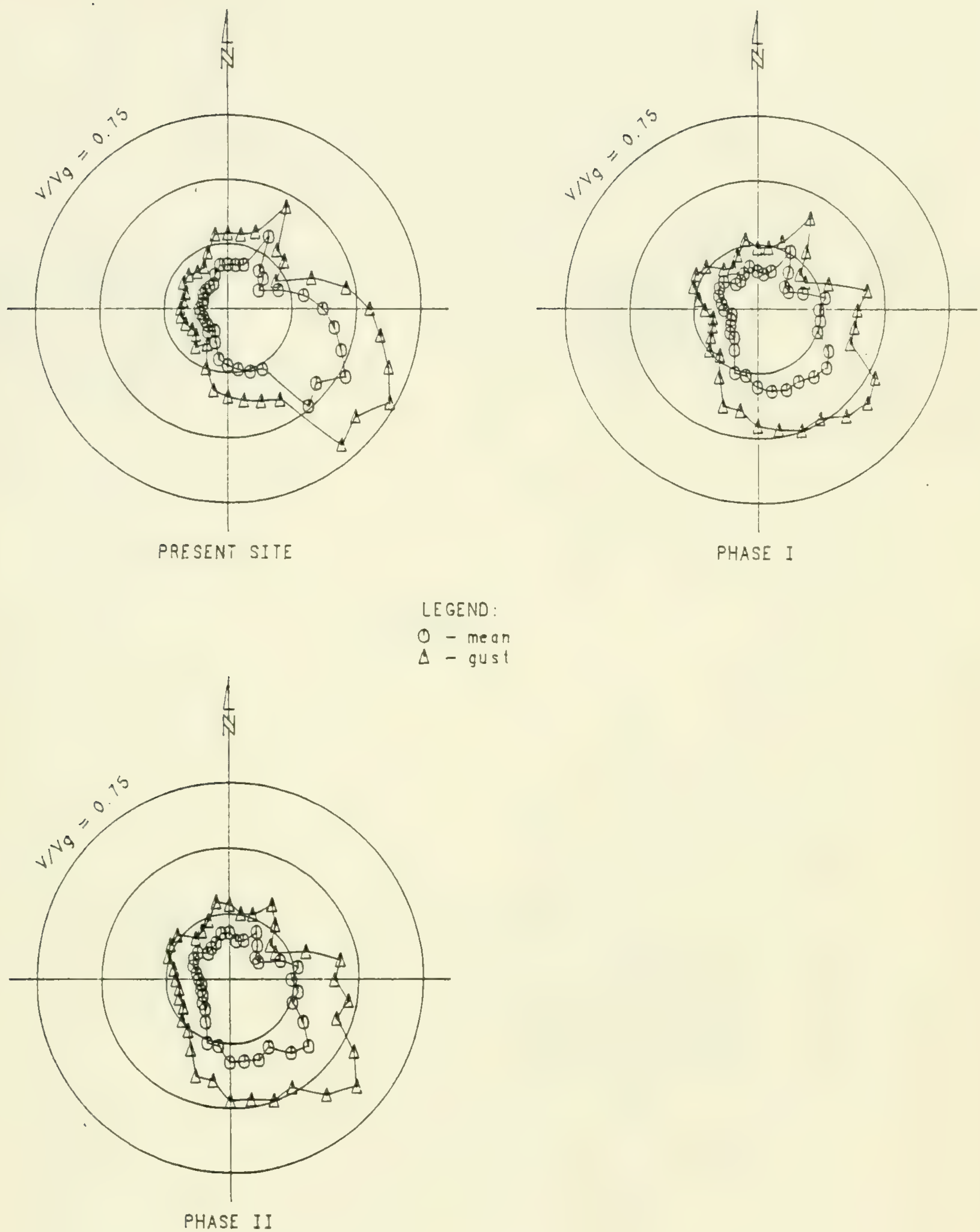
LEGEND:
O - mean
Δ - gust



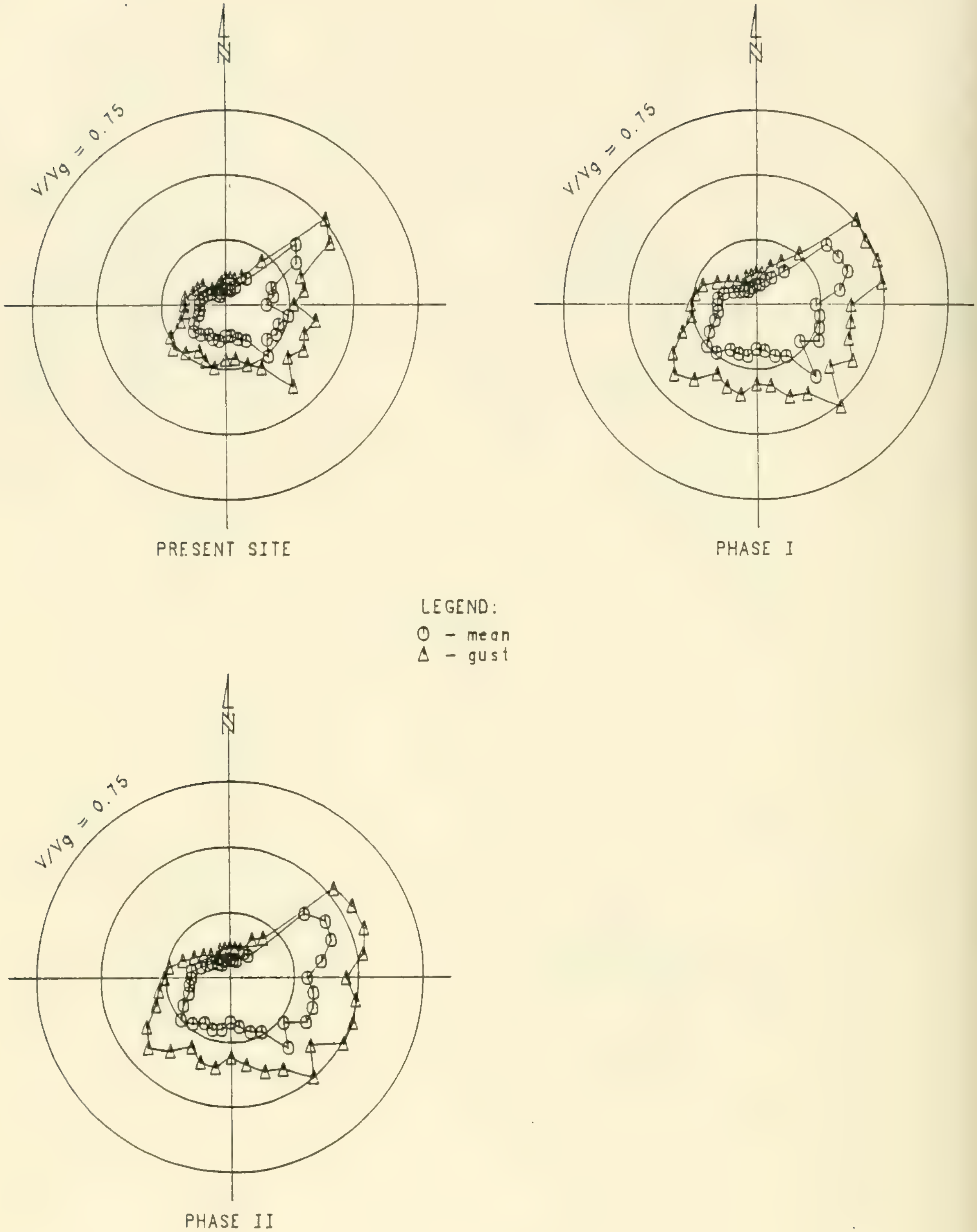
PHASE II

WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS

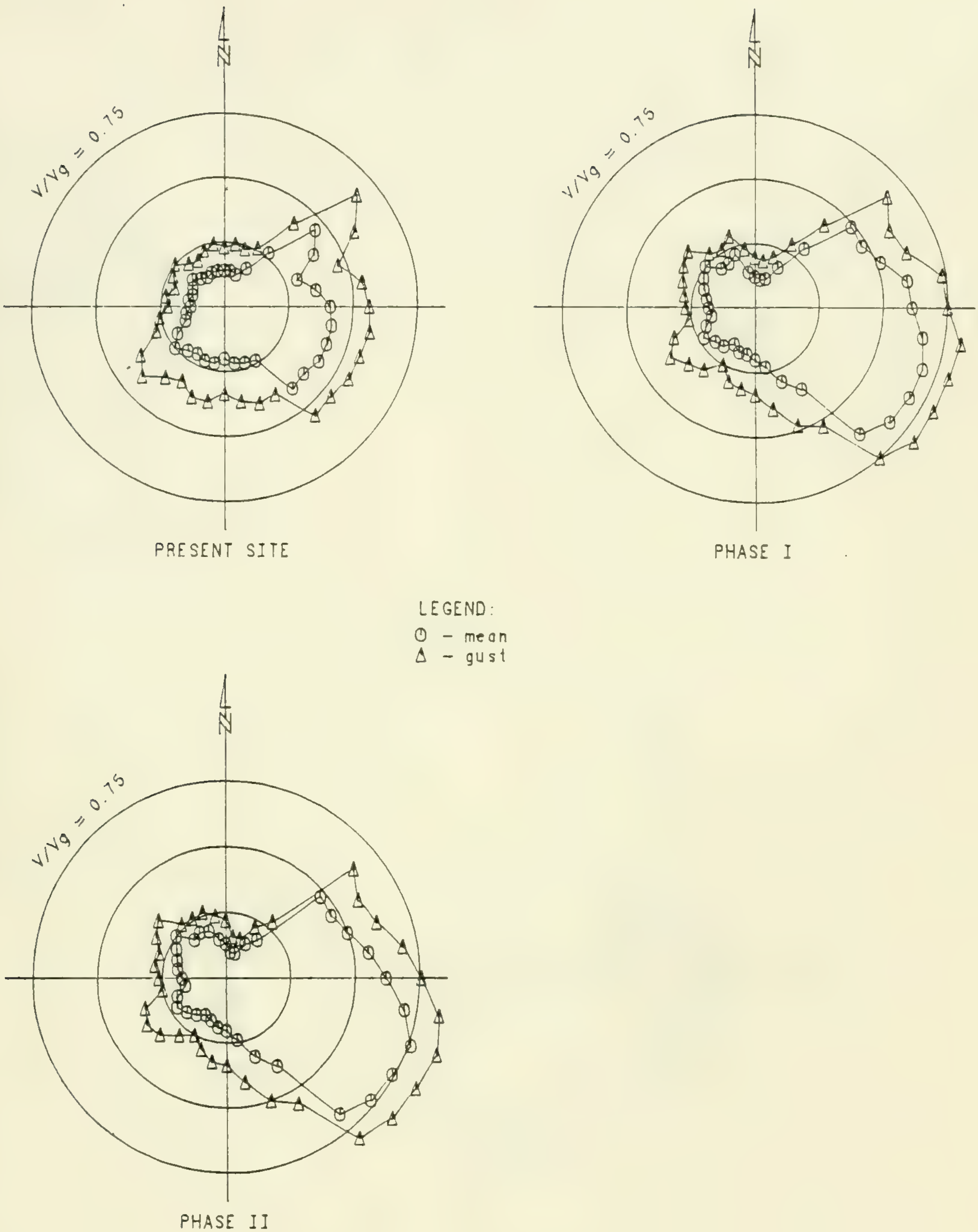
PROBE LOCATION 20



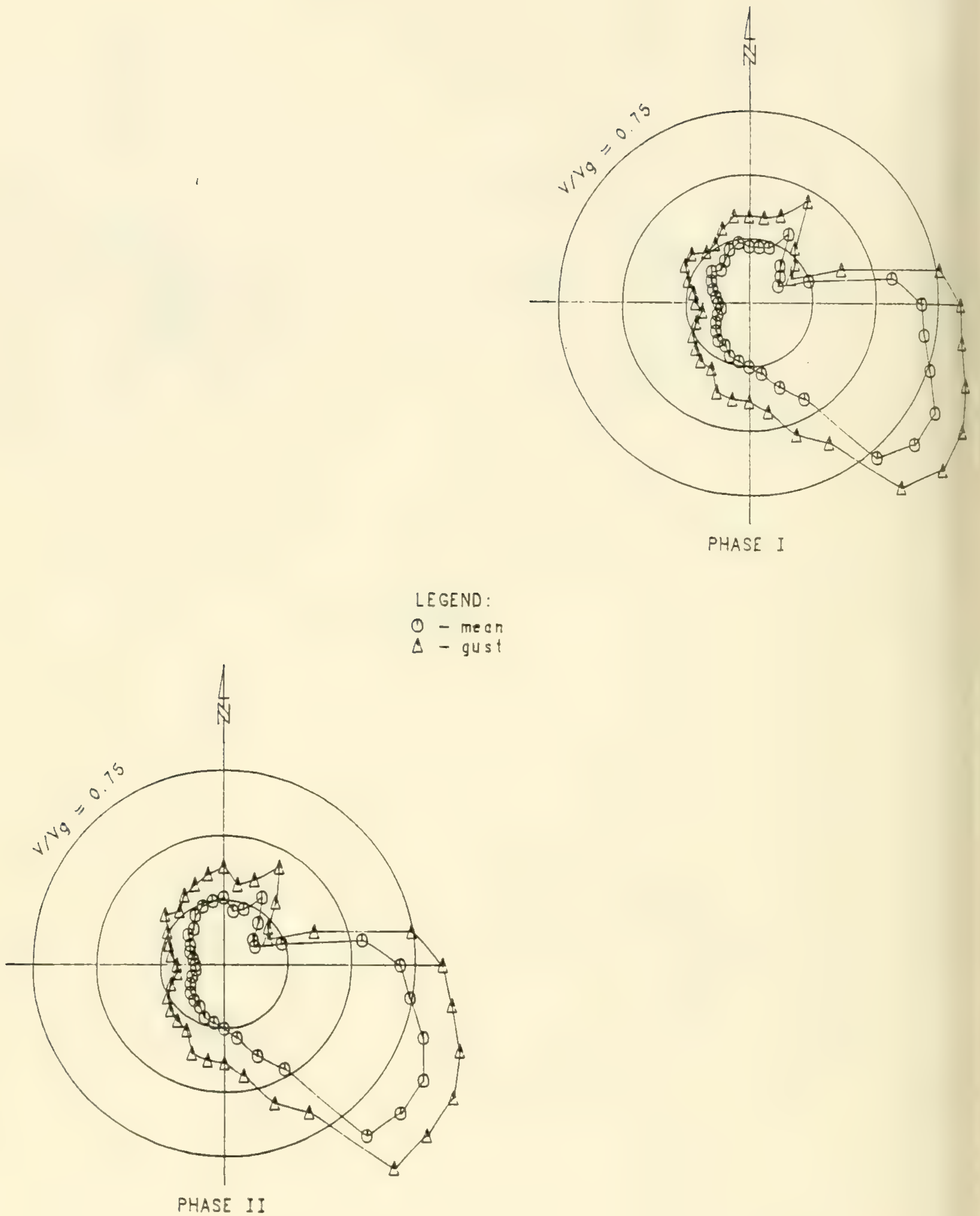
WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 21



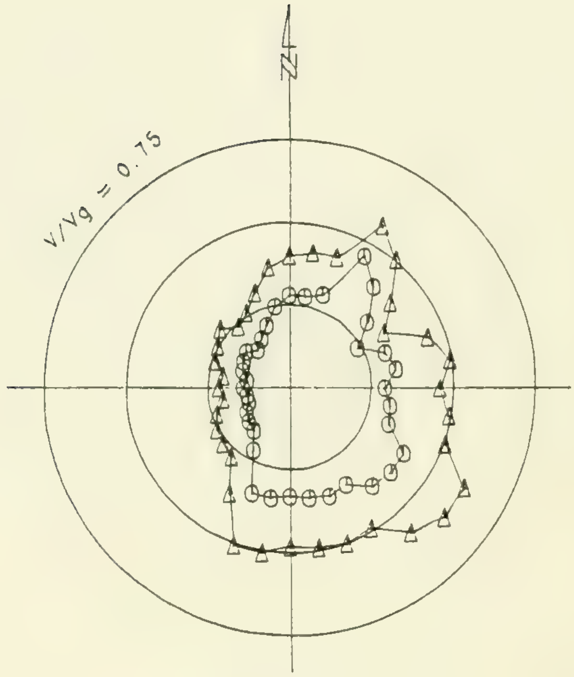
WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 22



WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 23

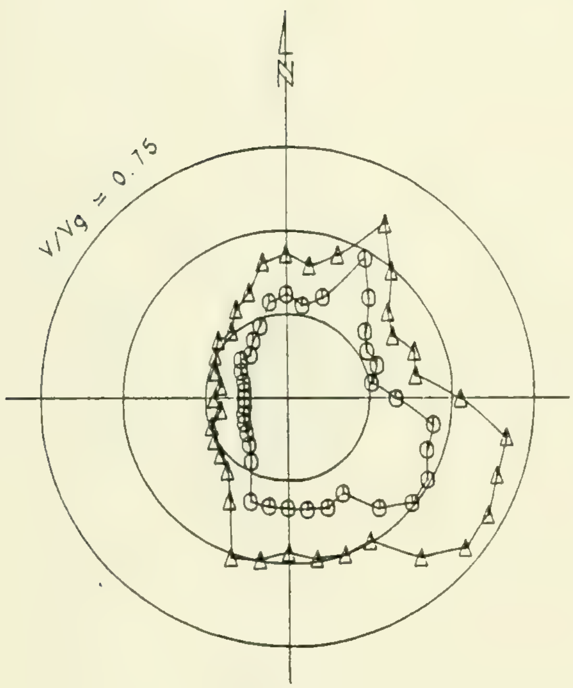


WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 24



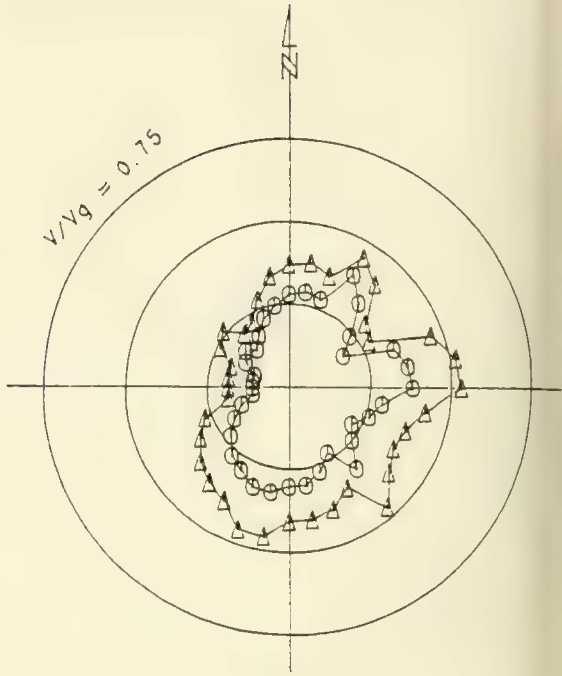
PHASE I

LEGEND:
O - mean
Δ - gust



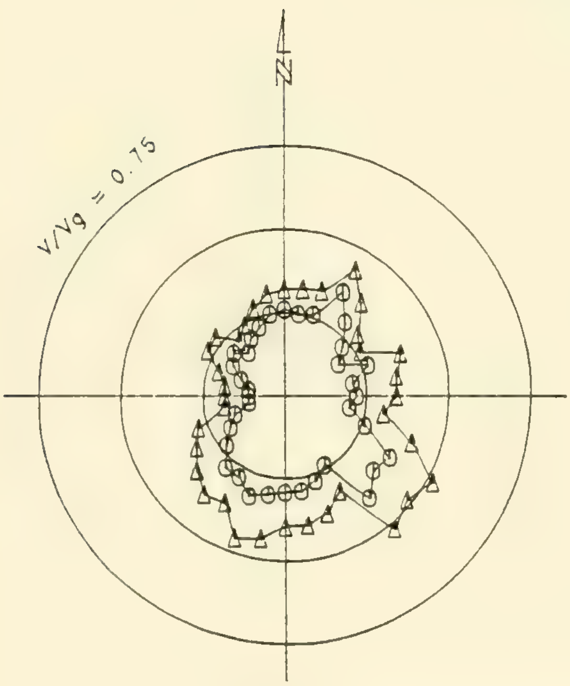
PHASE II

WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 25



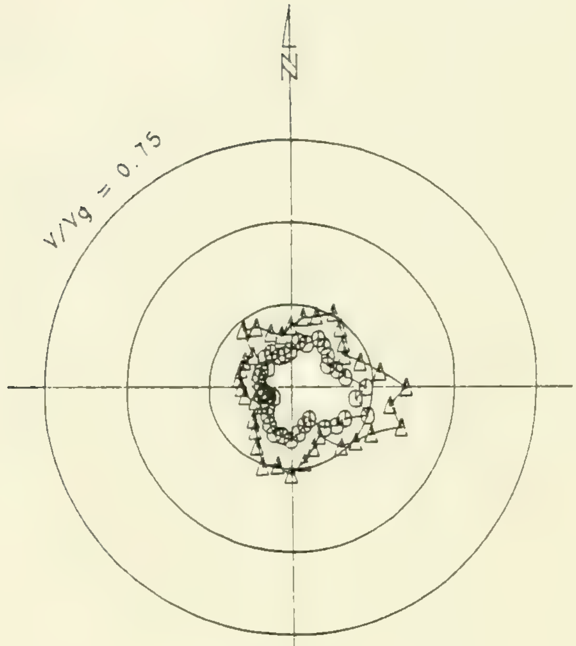
PHASE I

LEGEND:
O – mean
Δ – gust



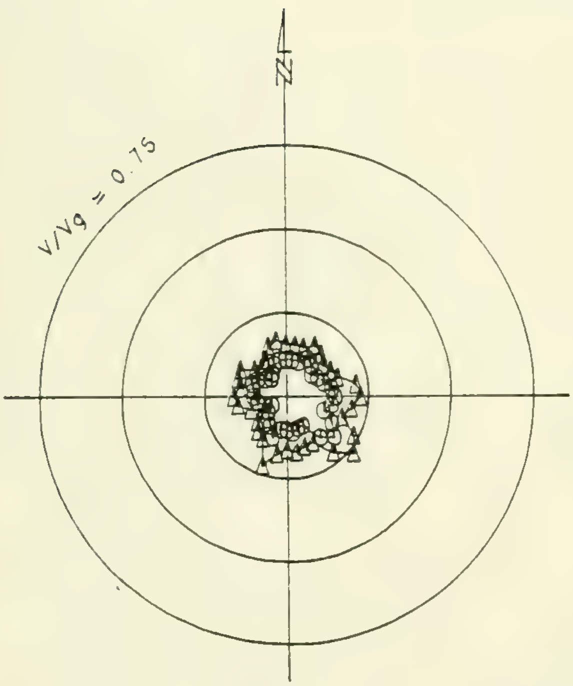
PHASE II

WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 26



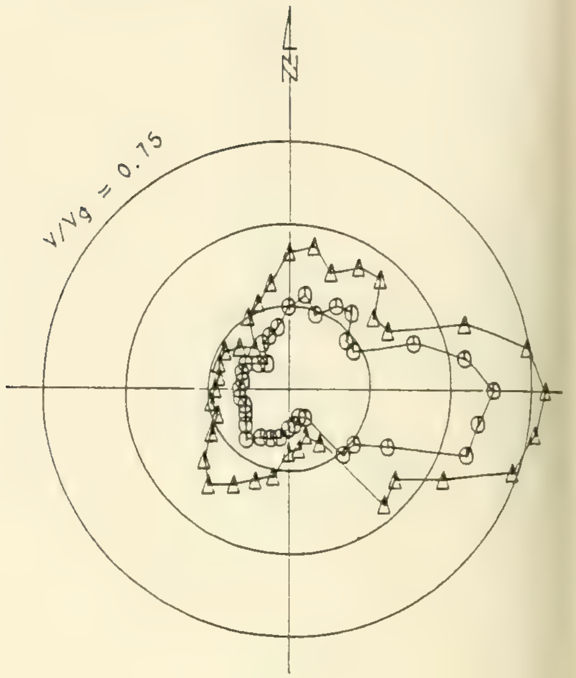
PHASE I

LEGEND:
O – mean
Δ – gust



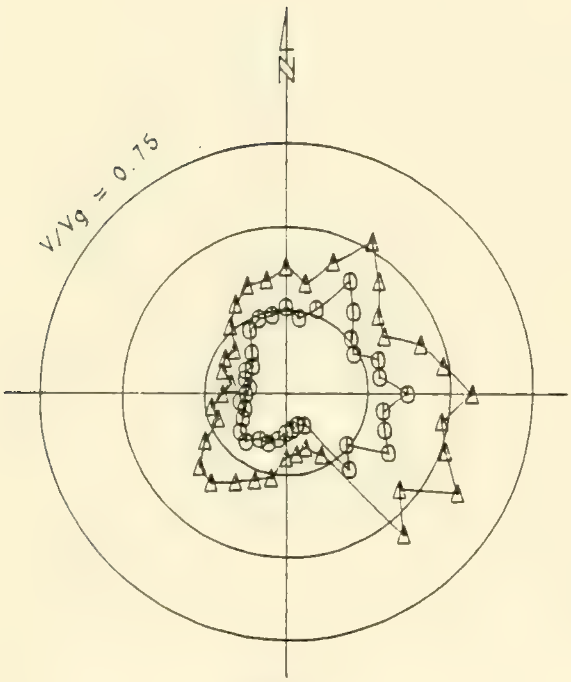
PHASE II

WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 27



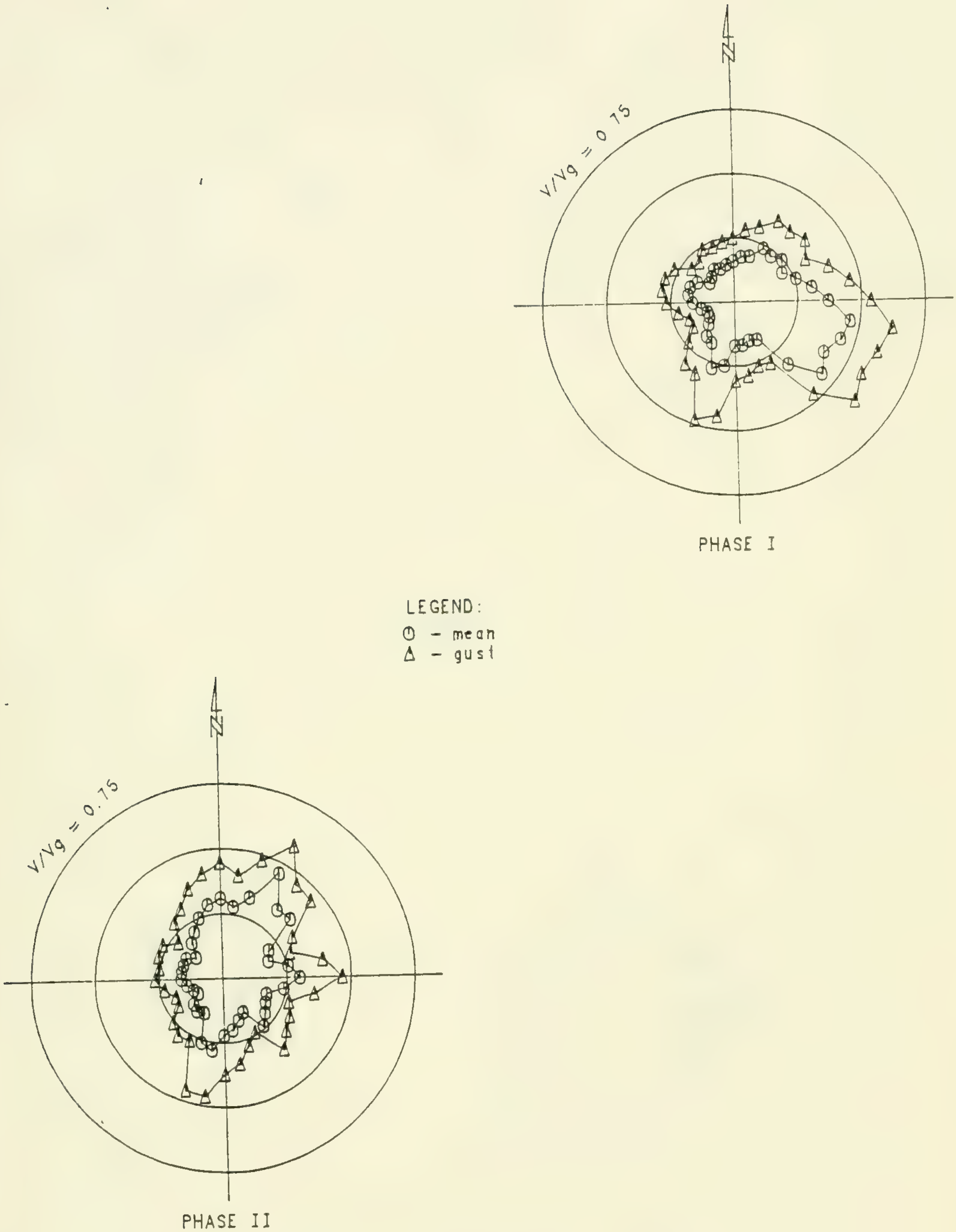
PHASE I

LEGEND:
O - mean
Δ - gust

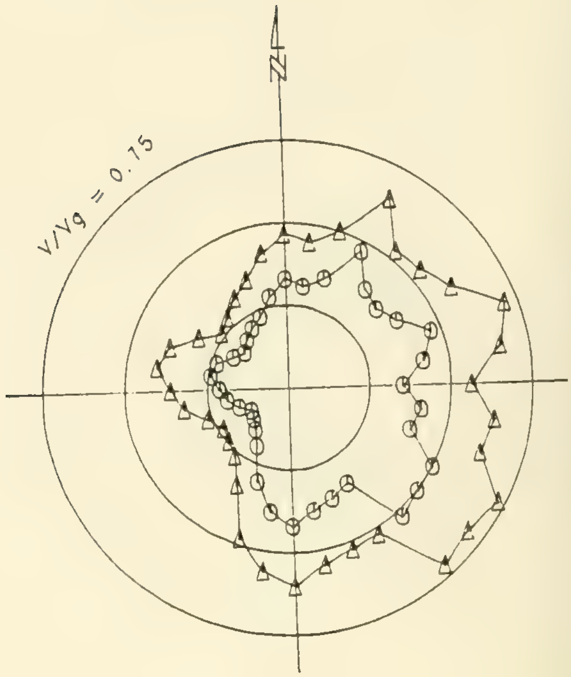


PHASE II

WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 28

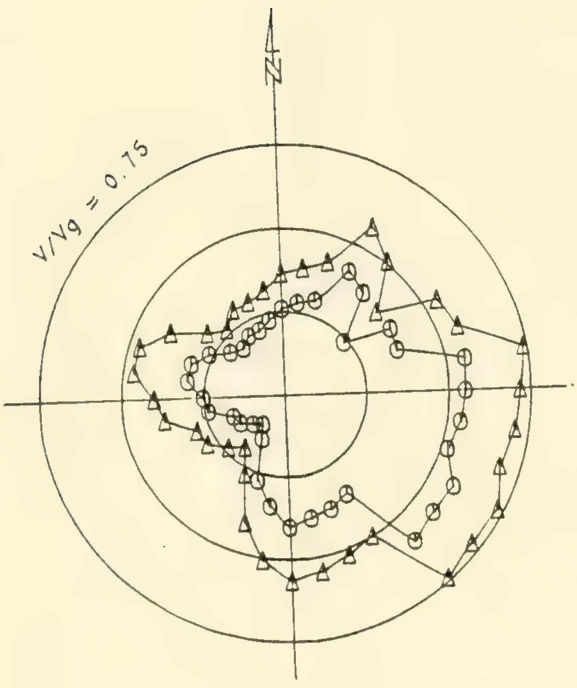


WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 29



PHASE I

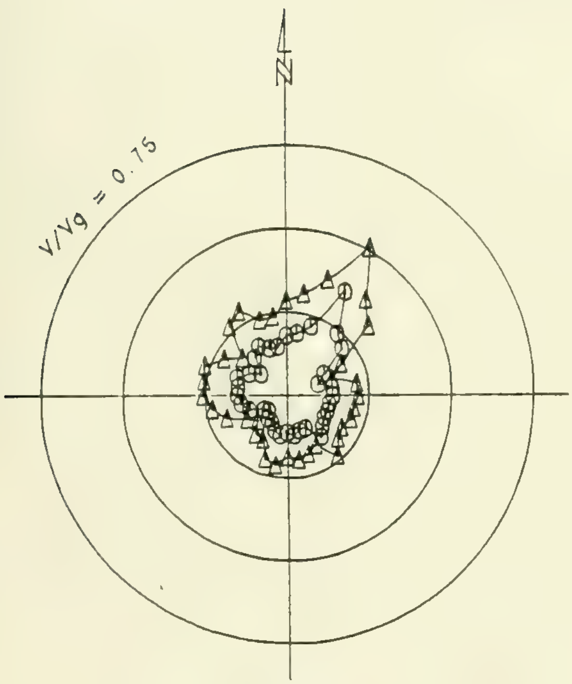
LEGEND:
O - mean
Δ - gust



PHASE II

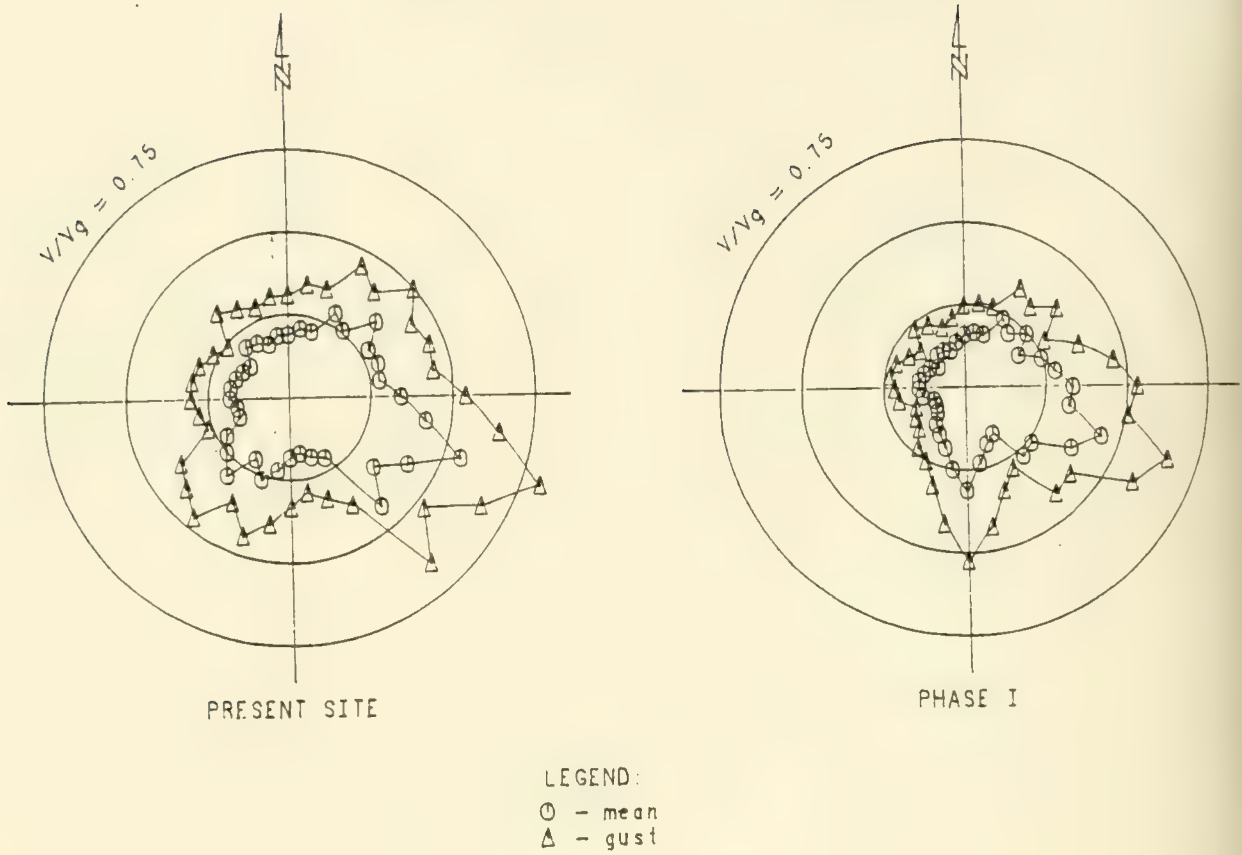
WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 30

LEGEND:
O - mean
Δ - gust

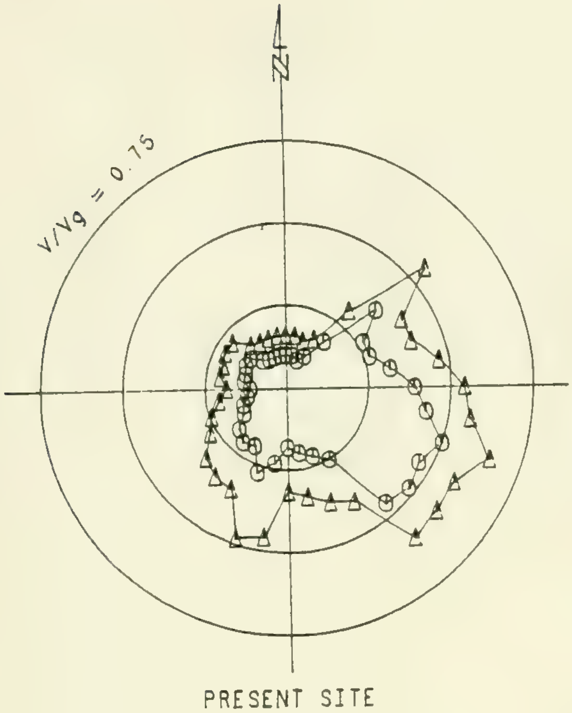


PHASE II

WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 31

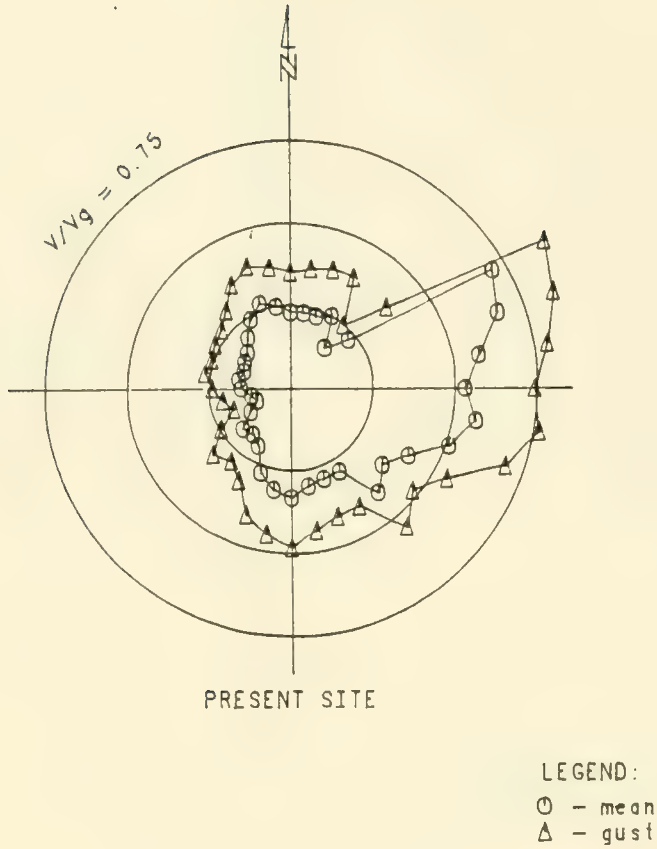


WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 32

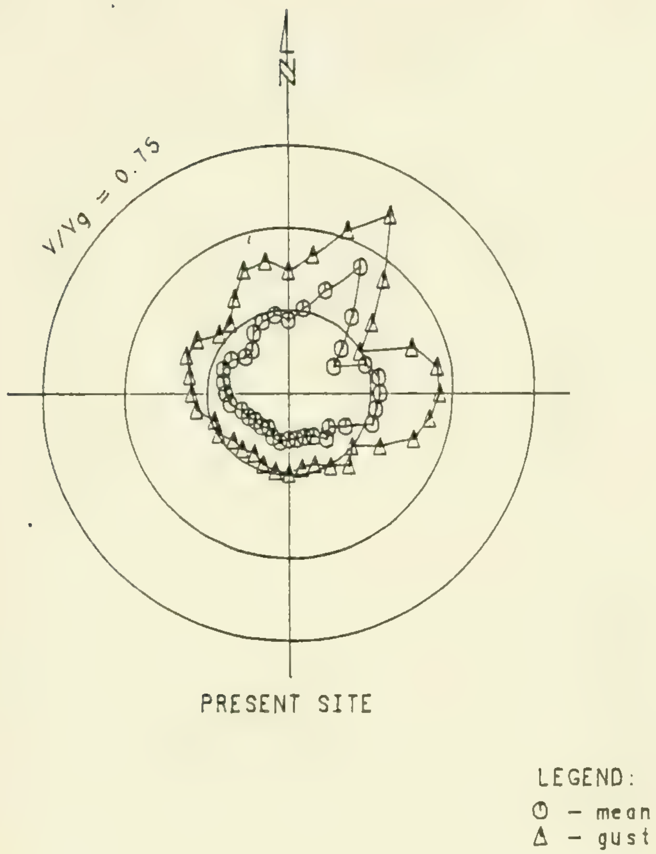


LEGEND:
O - mean
Δ - gust

WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 33



WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 34



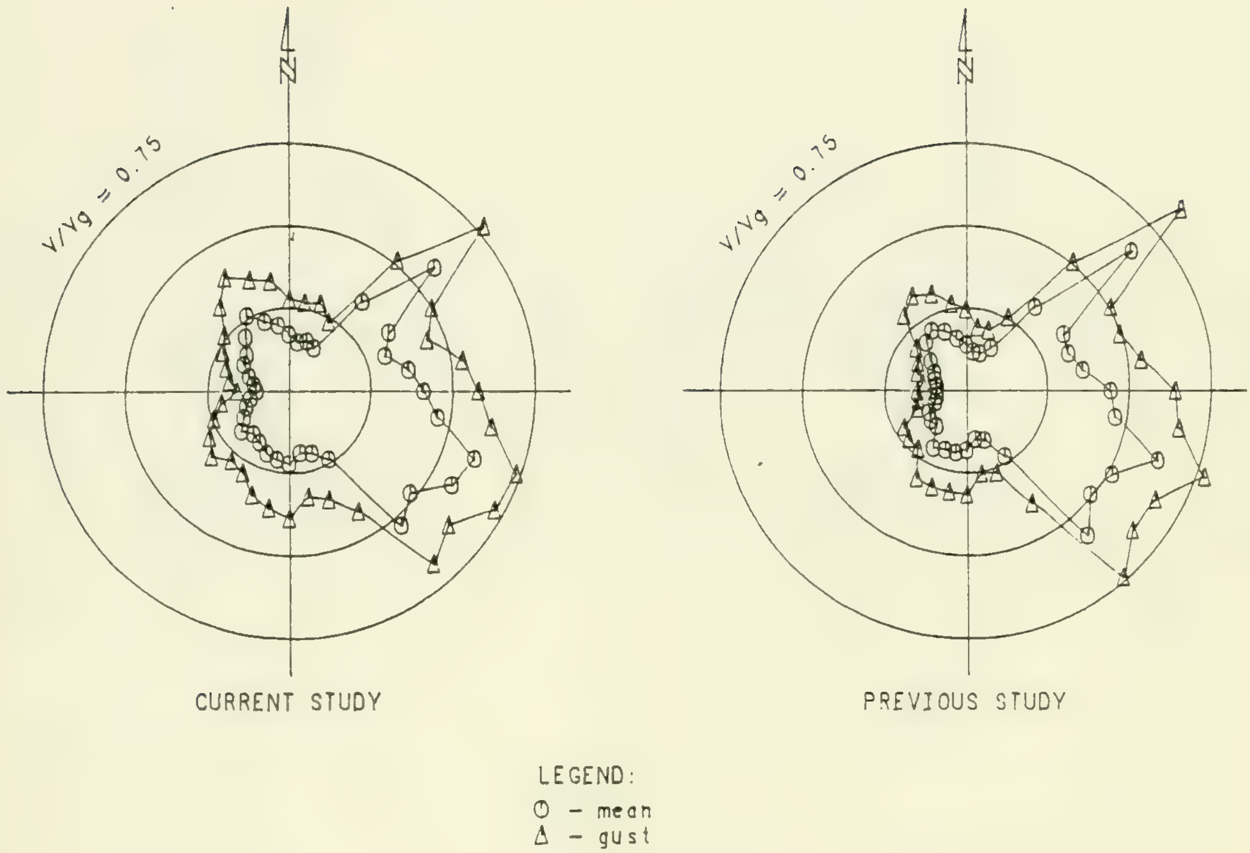
WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 35

SECTION B-4

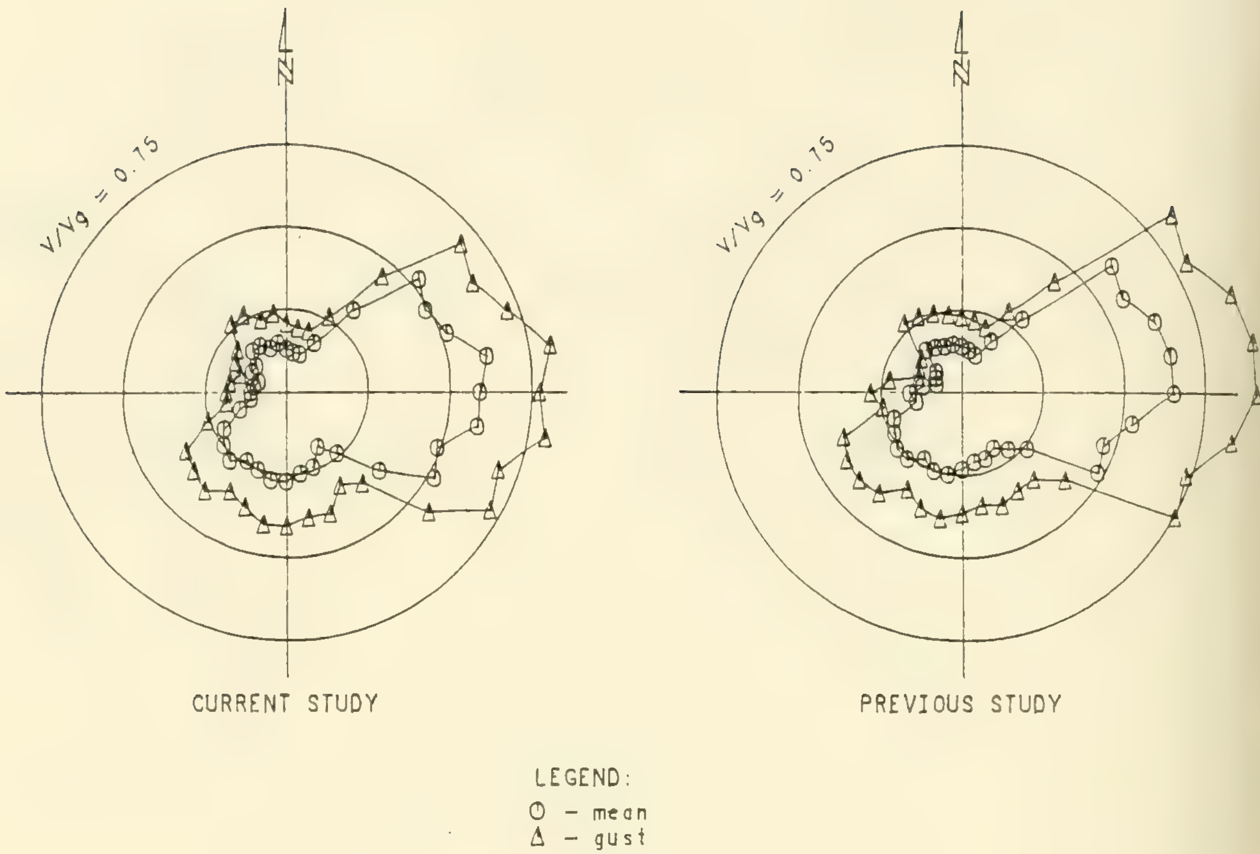
COMPARISON OF POLAR PLOTS OF MEAN AND GUST
WIND SPEEDS FOR THE CURRENT STUDY
WITH THE PREVIOUS MASSINGS STUDY

COMPARISON OF POLAR PLOTS OF MEAN AND GUST WIND SPEEDS FOR THE CURRENT STUDY WITH THE PREVIOUS STUDY (Ref.1)

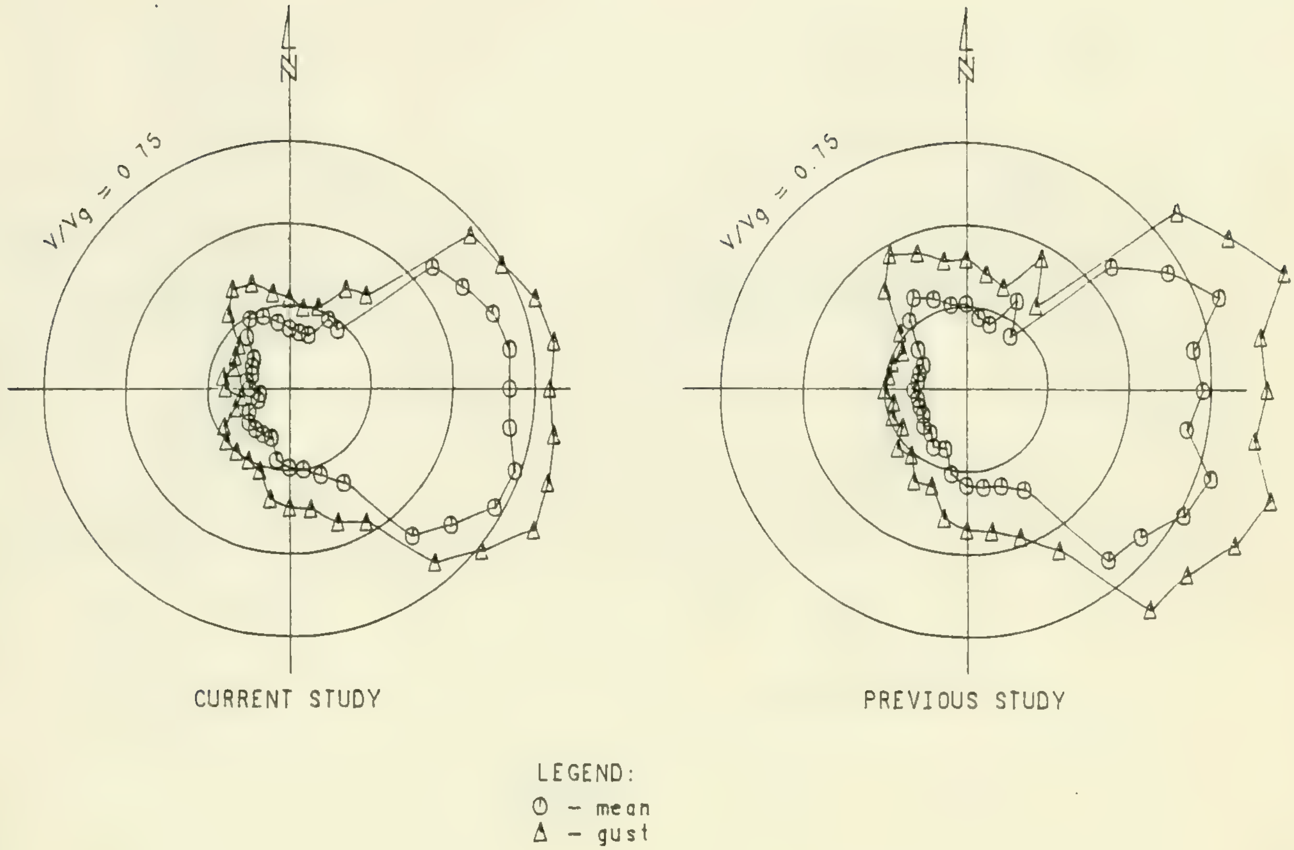
Note: For each gradient wind direction, the plots represent the fraction of the gradient wind speed expected at ground level. Each plot shows both the mean speed and an effective gust speed, defined as gust = mean + 1.5 RMS. This particular definition leads to a gust speed to which humans are expected to be sensitive. Further background for its definition canbe found in Ref. 5.



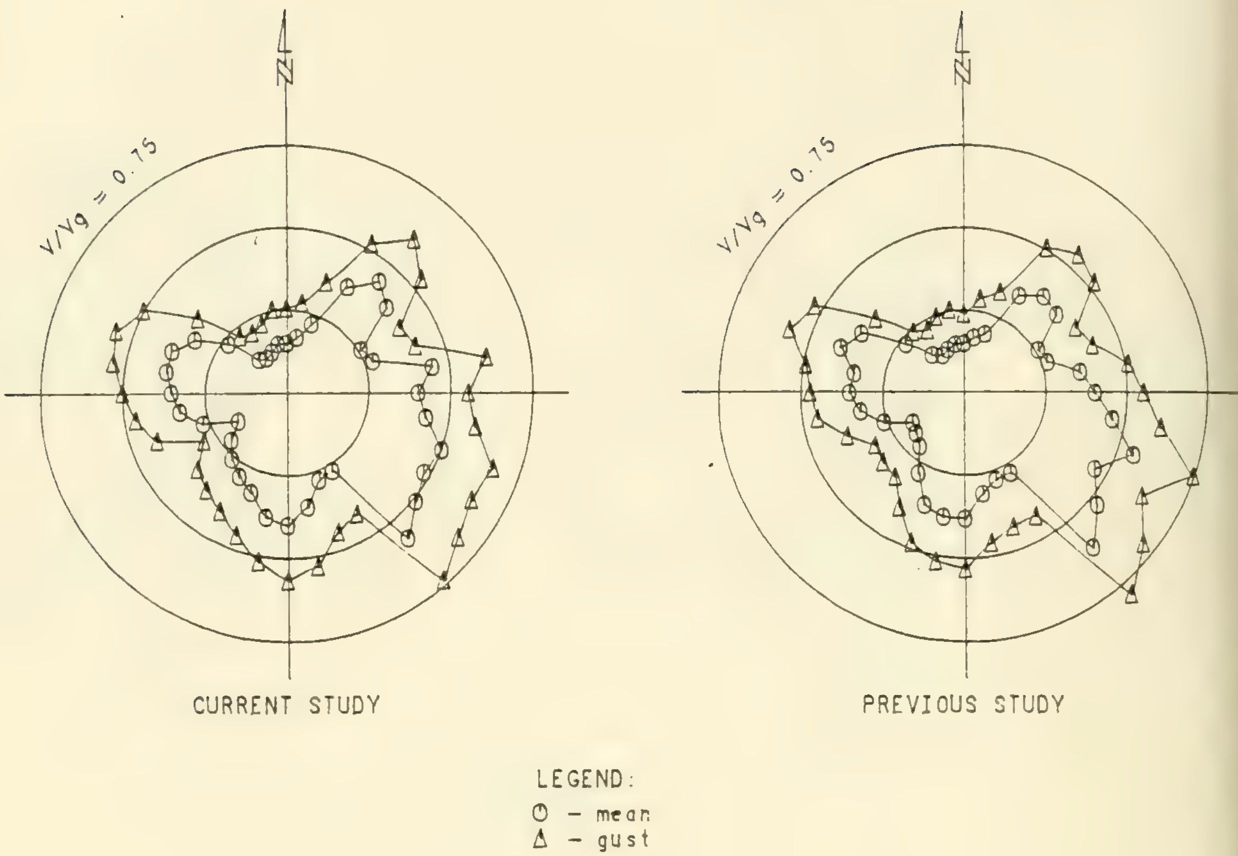
WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 4



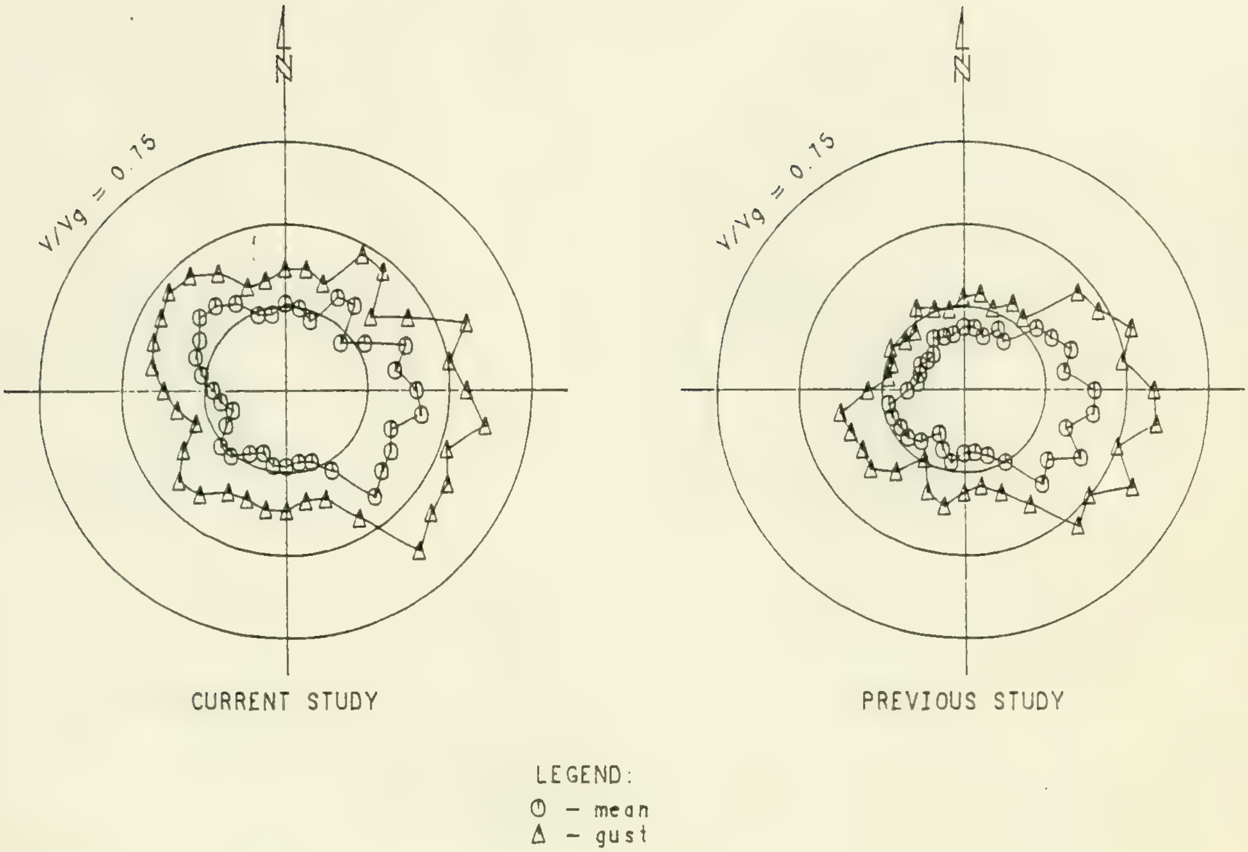
WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 5



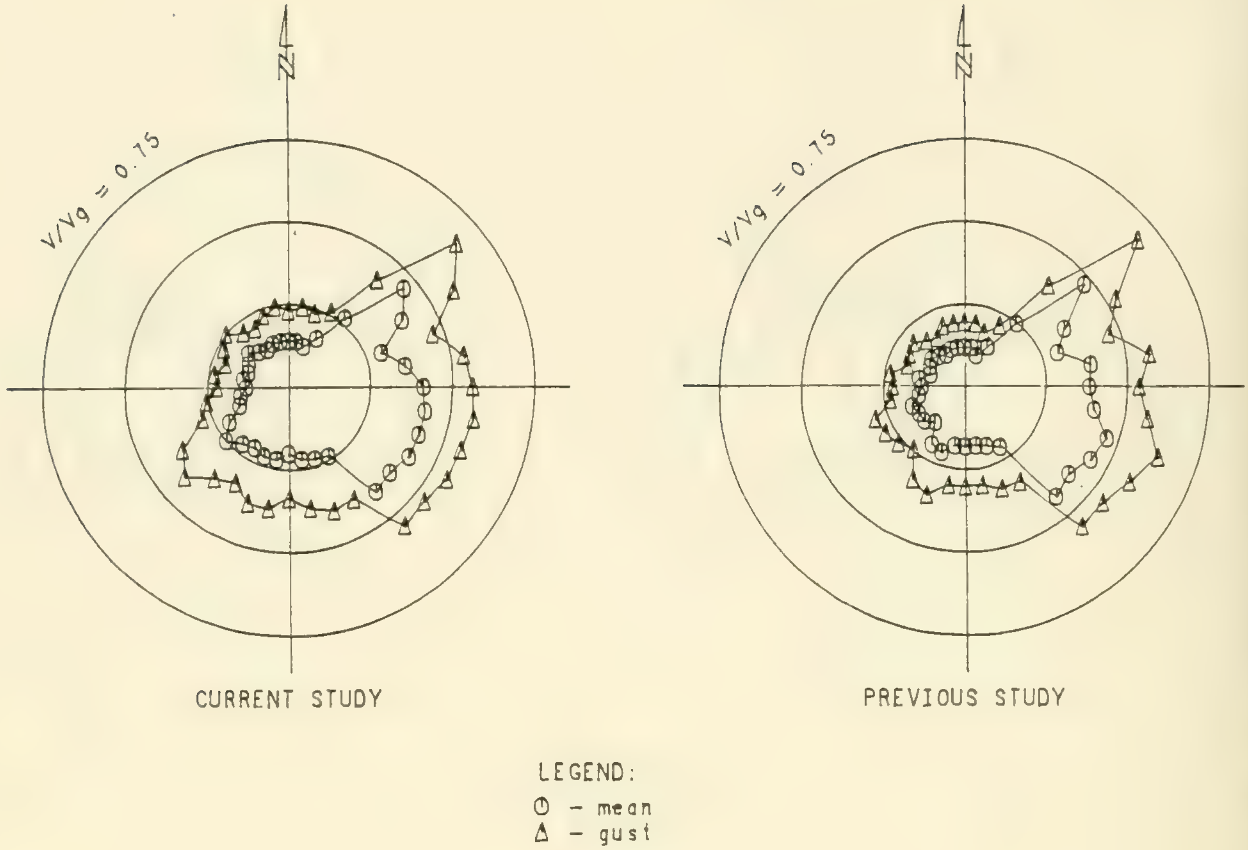
WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 9



WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 13



WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 20



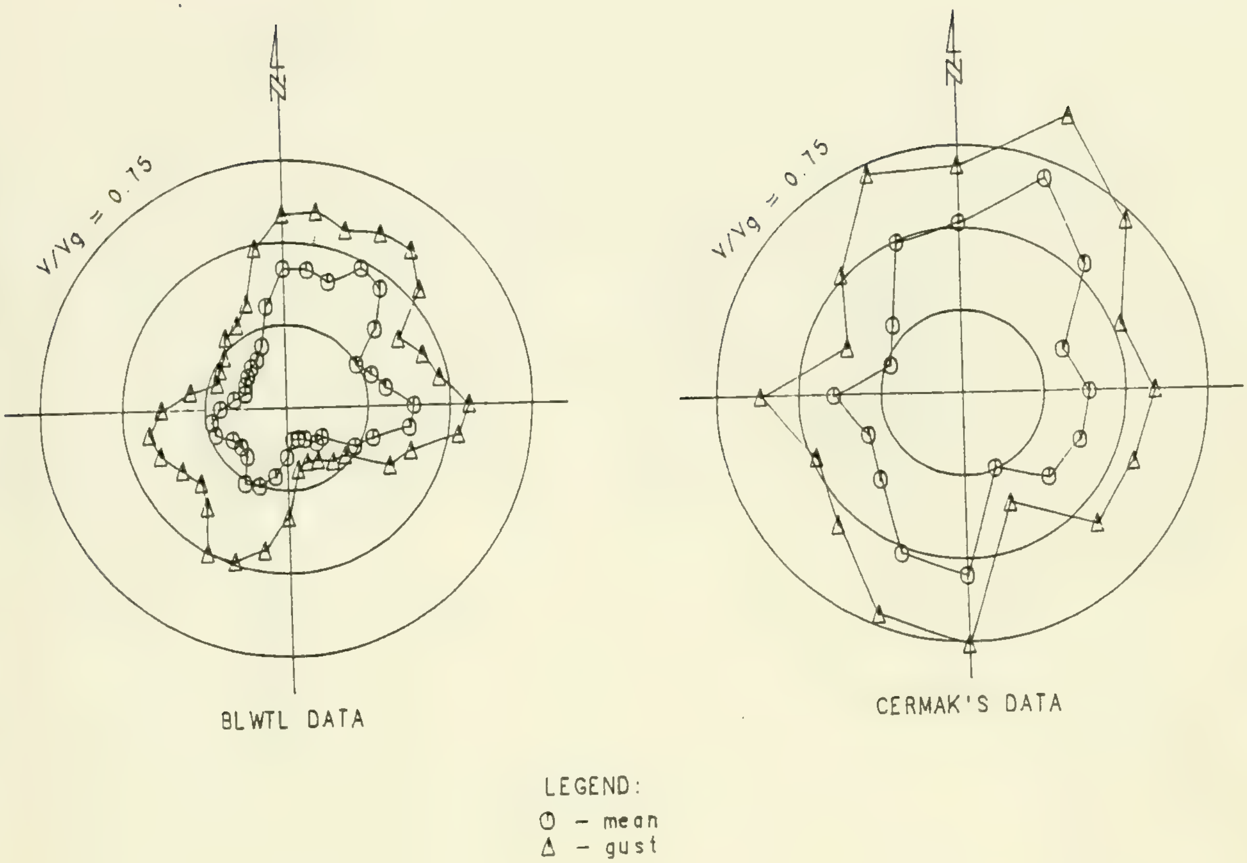
WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 23

SECTION B-5

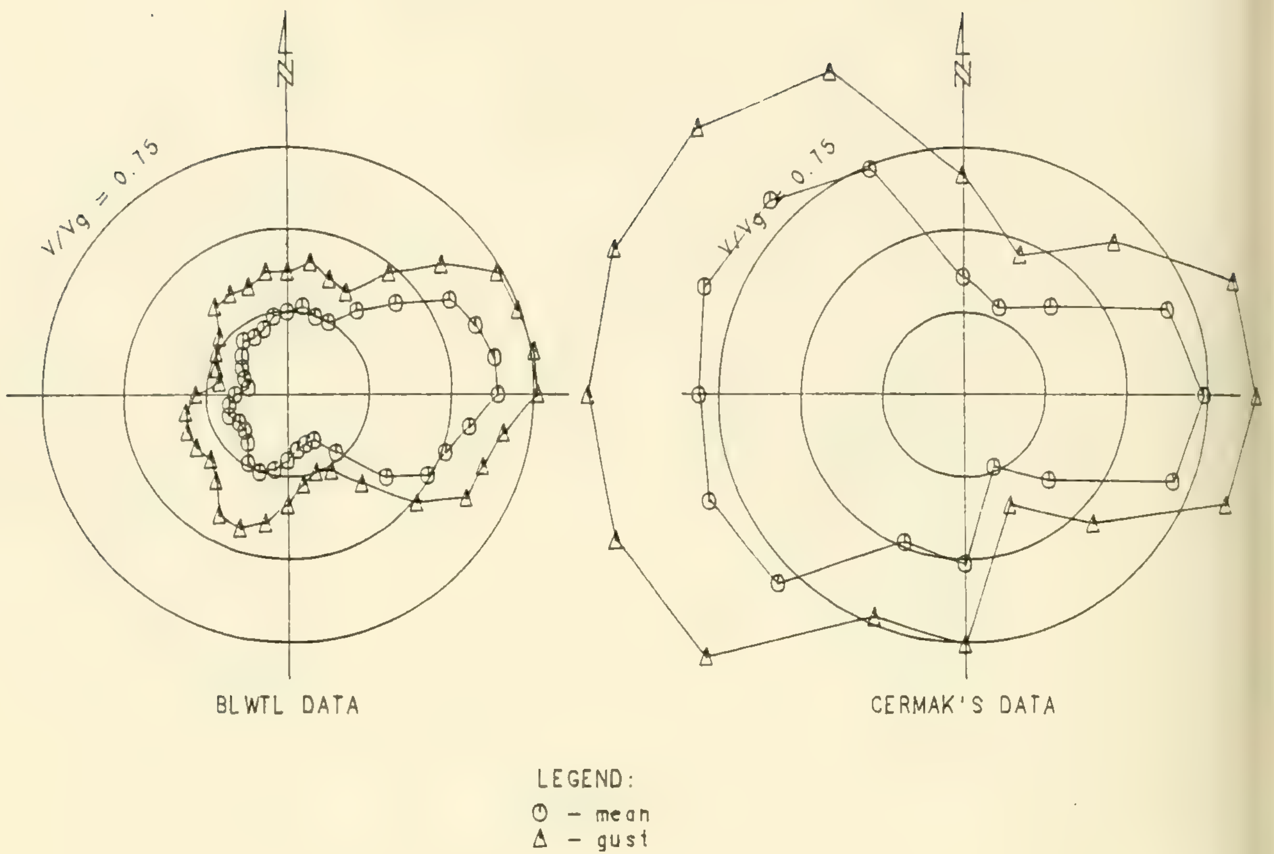
COMPARISON OF POLAR PLOTS OF MEAN AND GUST
WIND SPEEDS FOR THE CURRENT STUDY
WITH THE INTERNATIONAL PLACE STUDY

COMPARISON OF POLAR PLOTS OF MEAN AND GUST WIND SPEEDS FOR THE CURRENT STUDY WITH THE INTERNATIONAL PLAZA STUDY (Ref.1)

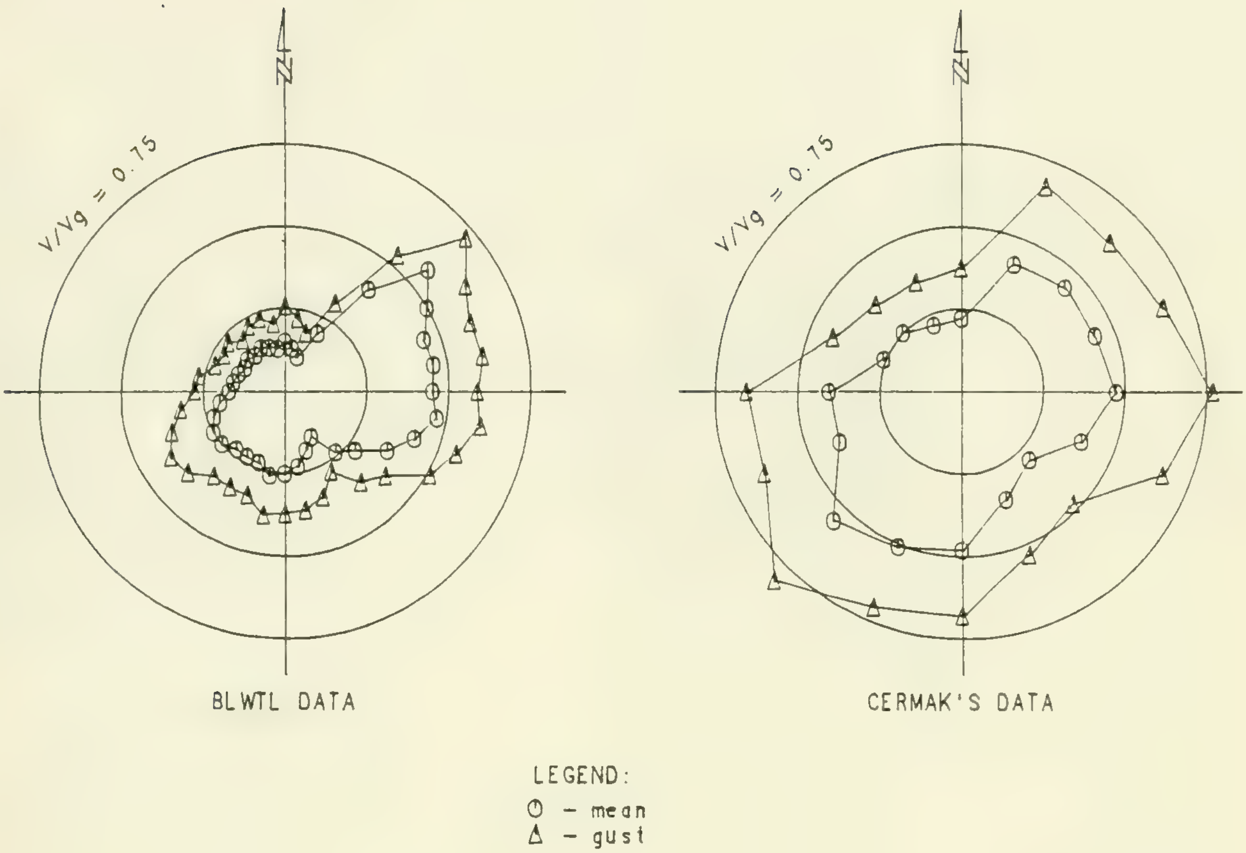
Note: For each gradient wind direction, the plots represent the fraction of the gradient wind speed expected at ground level. Each plot shows both the mean speed and an effective gust speed, defined as gust = mean + 1.5 RMS. This particular definition leads to a gust speed to which humans are expected to be sensitive. Further background for its definition canbe found in Ref. 5.



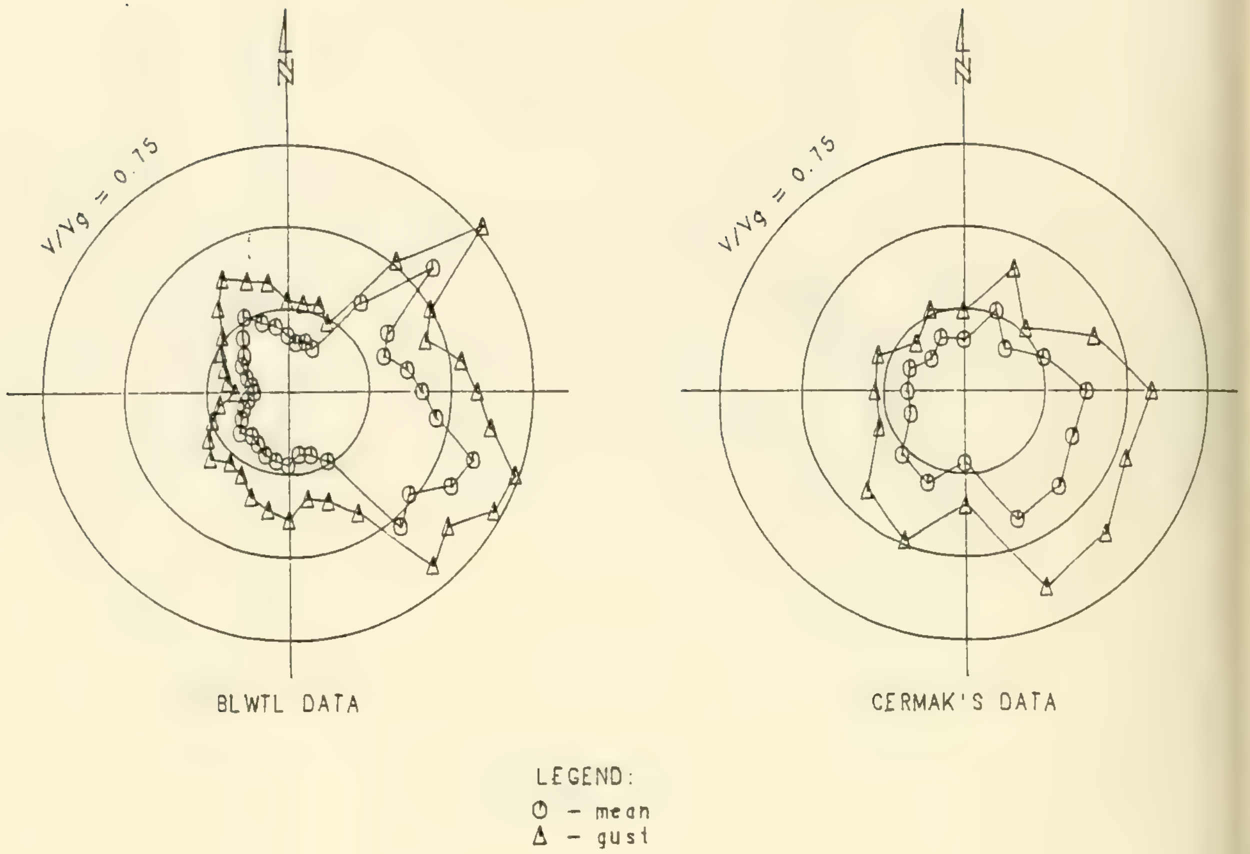
WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 1



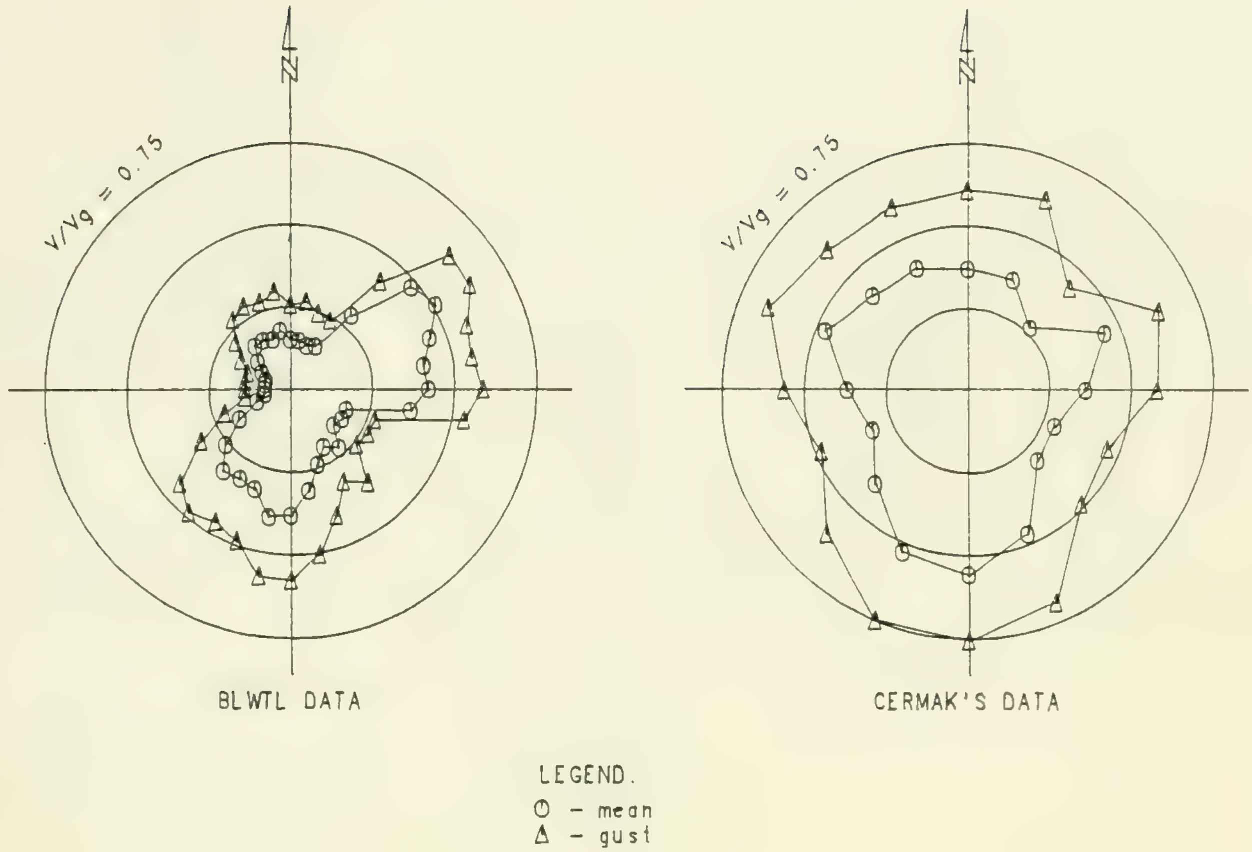
WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 2



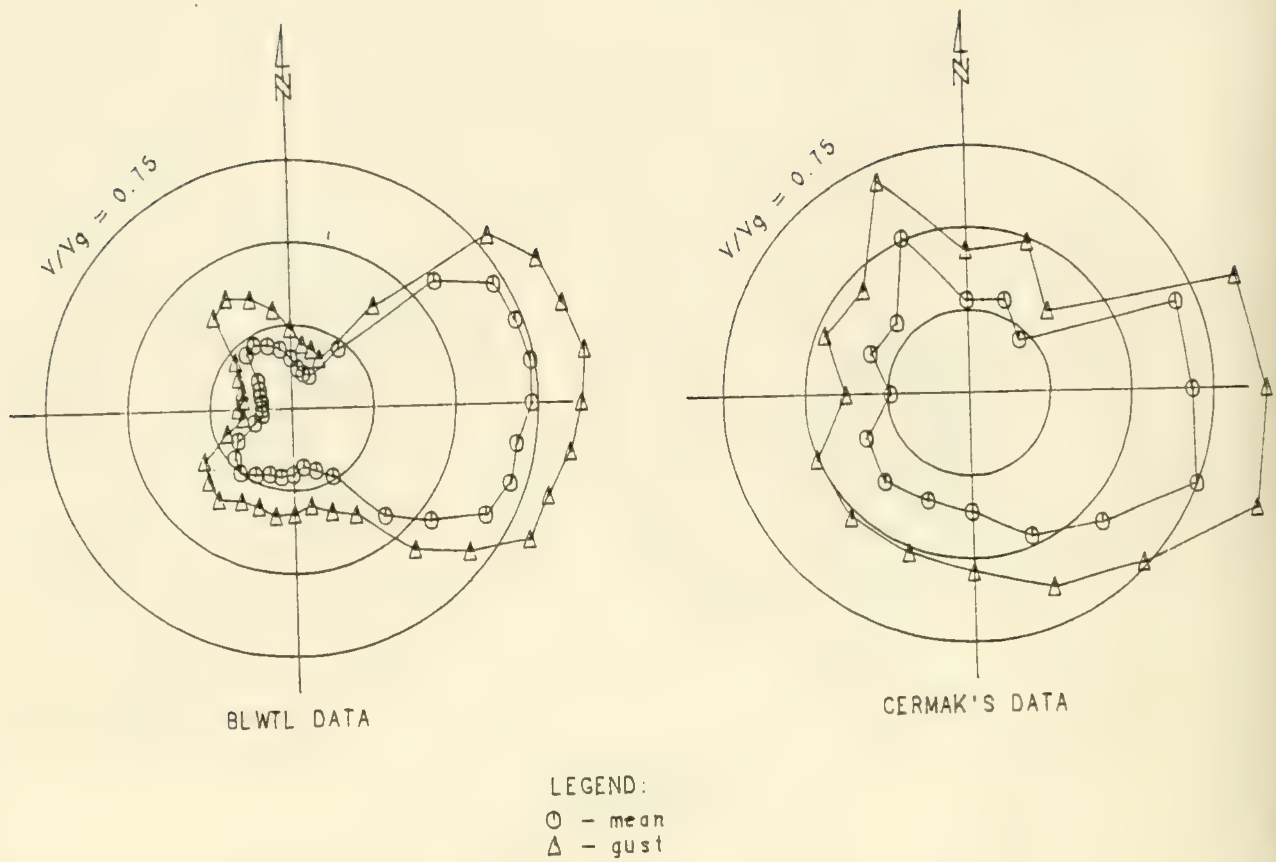
WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 3



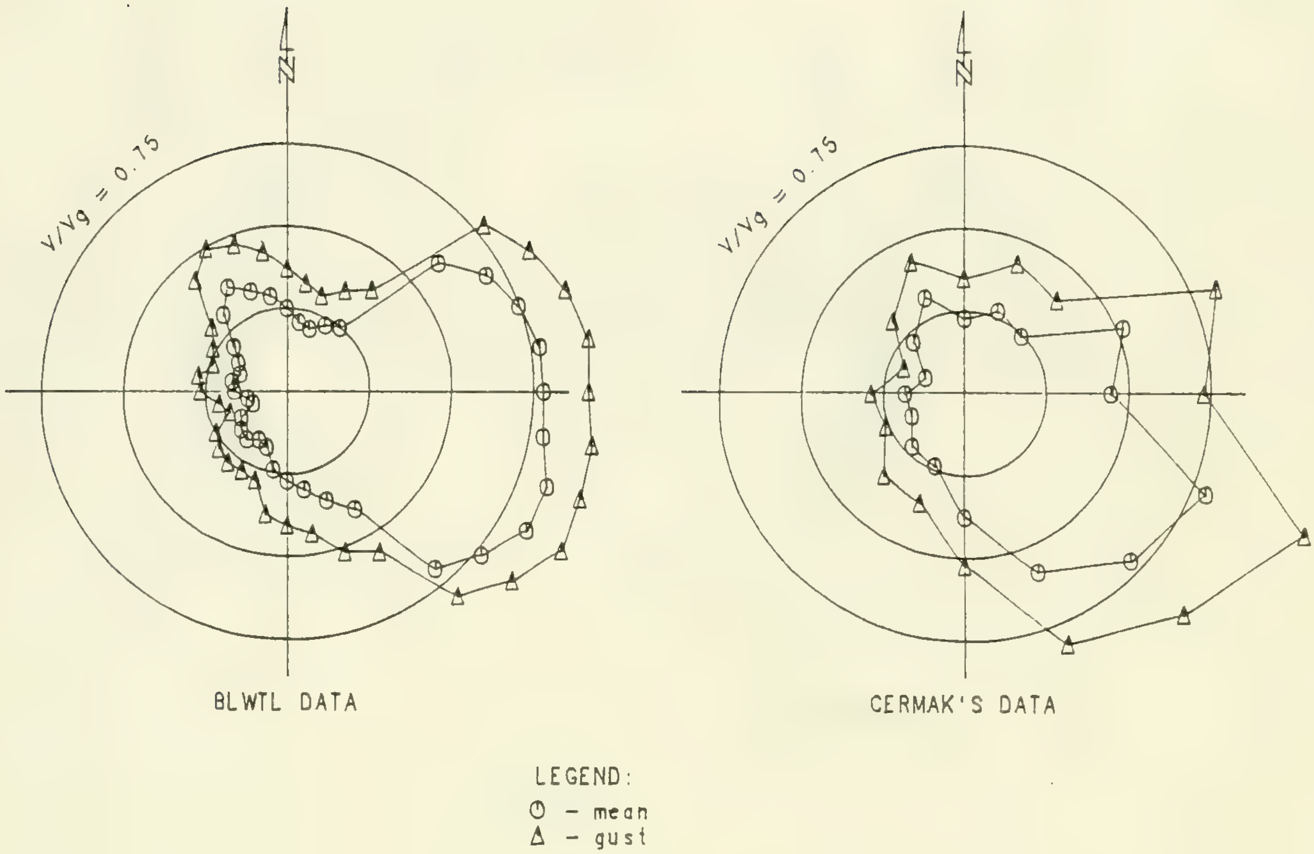
WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 4



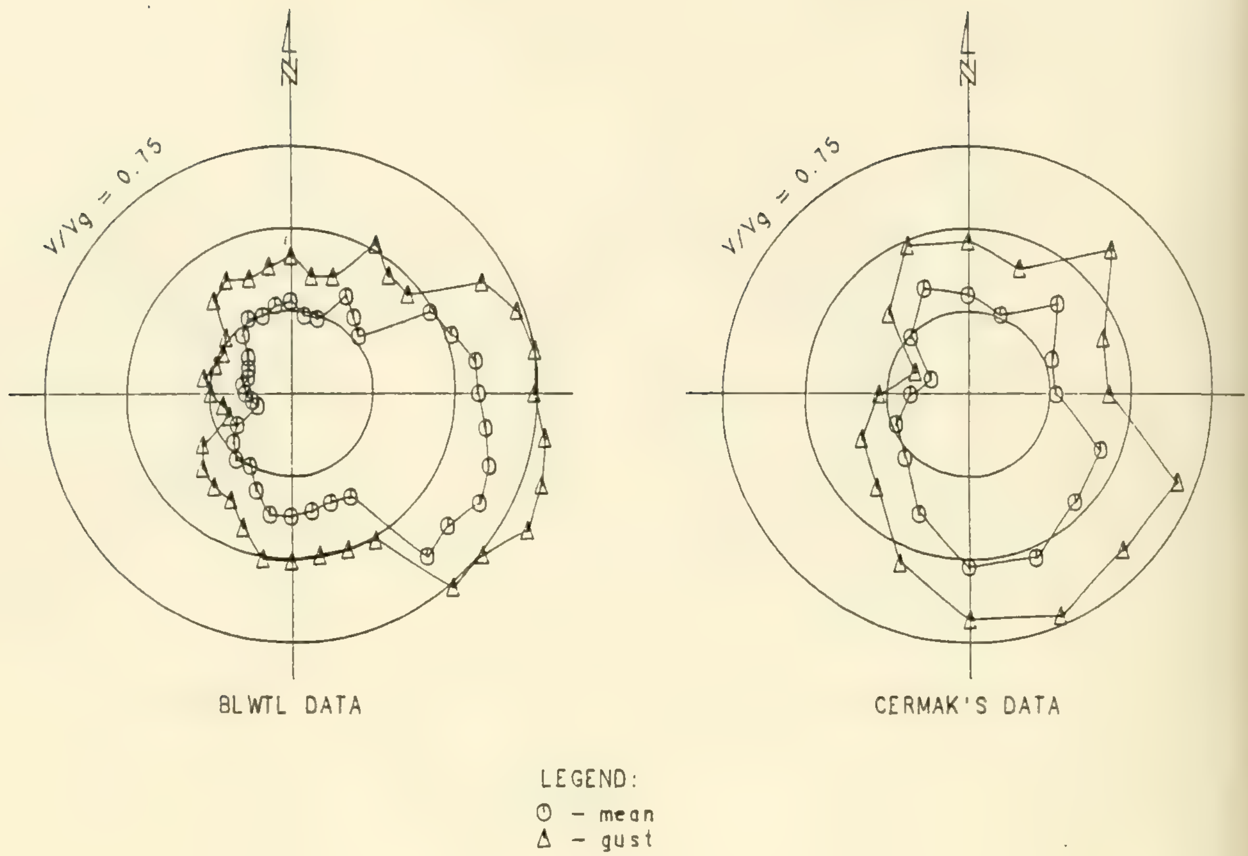
WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 6



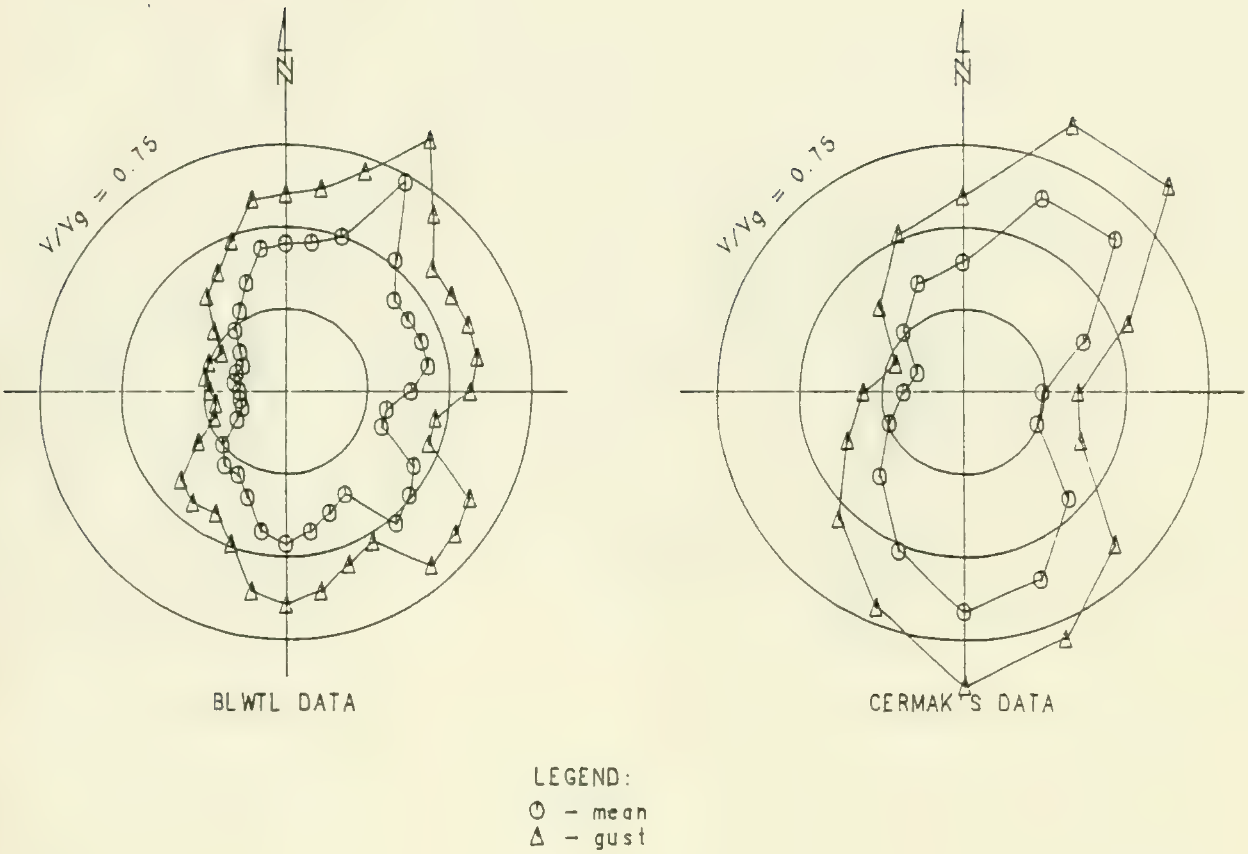
WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 7



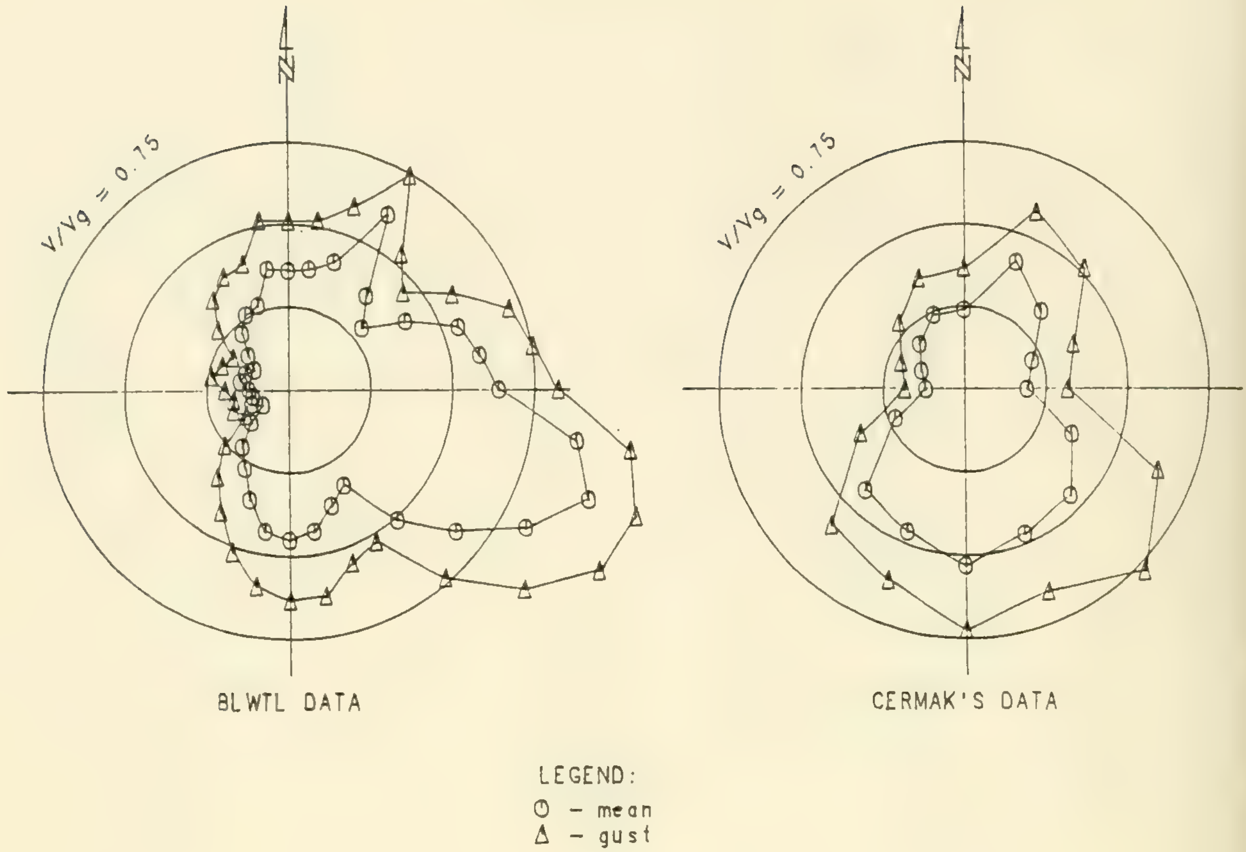
WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 8



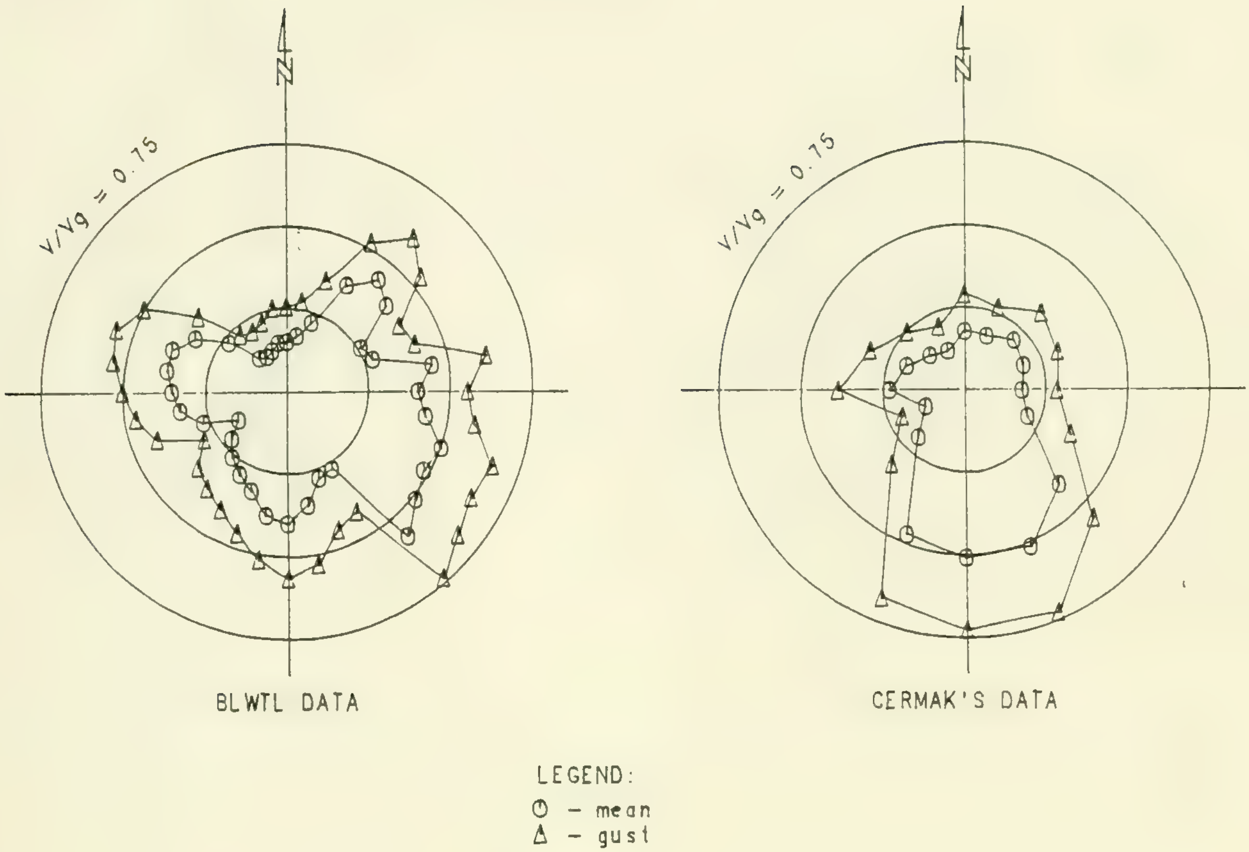
WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 10



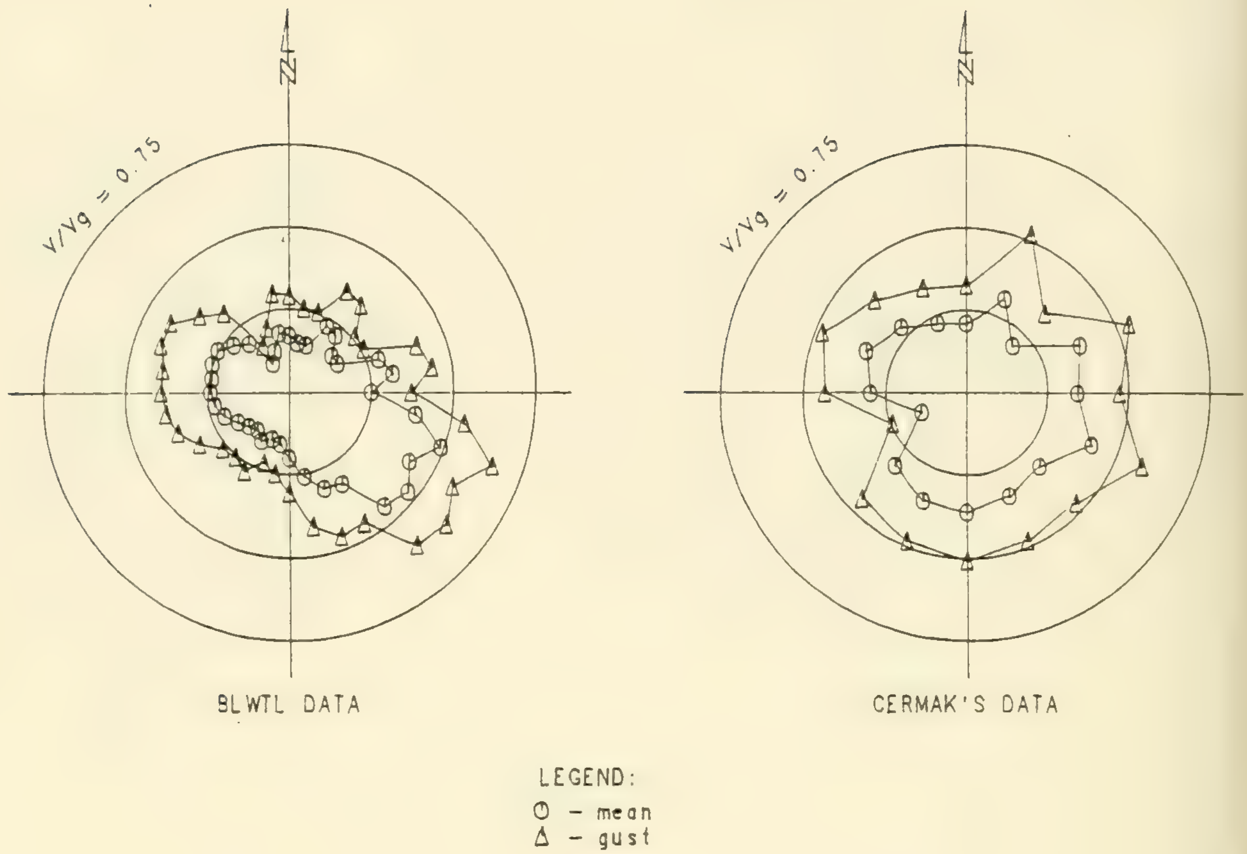
WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 11



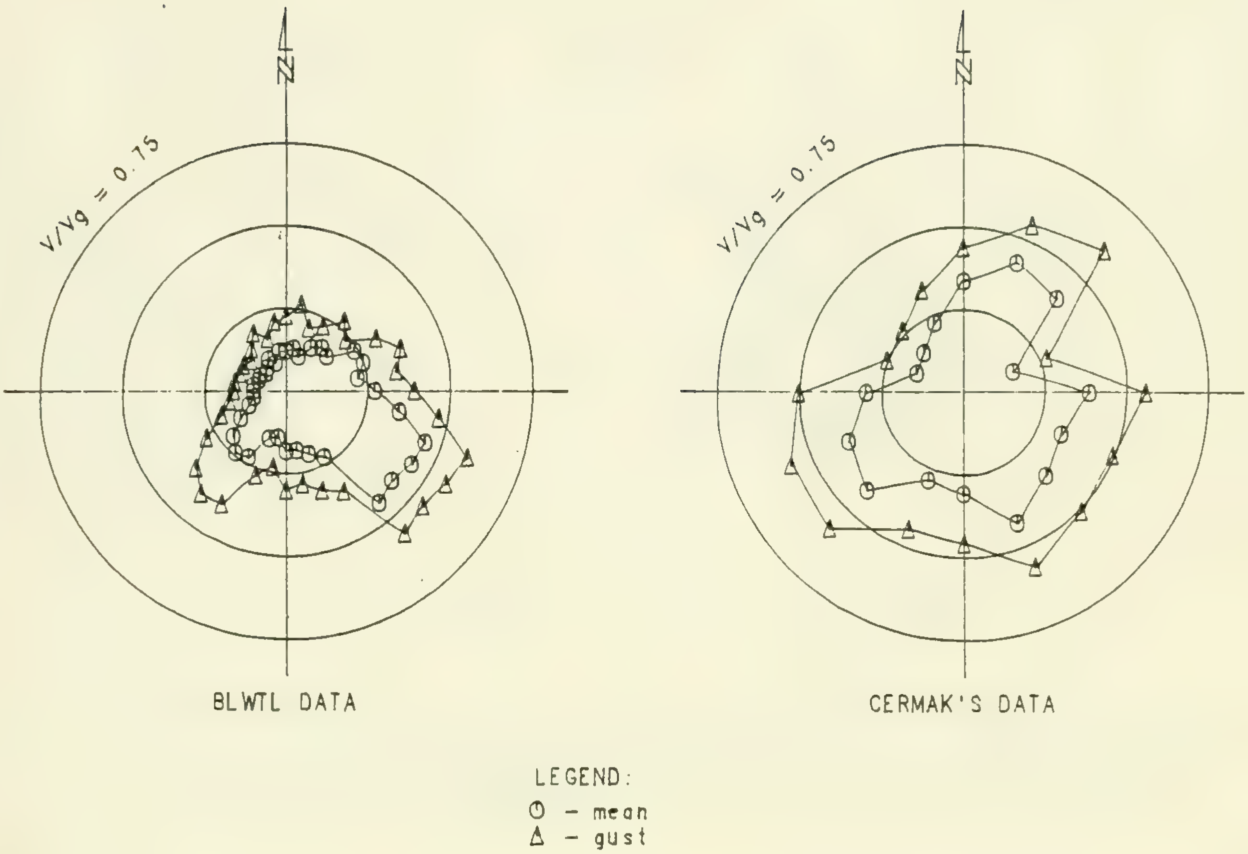
WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 12



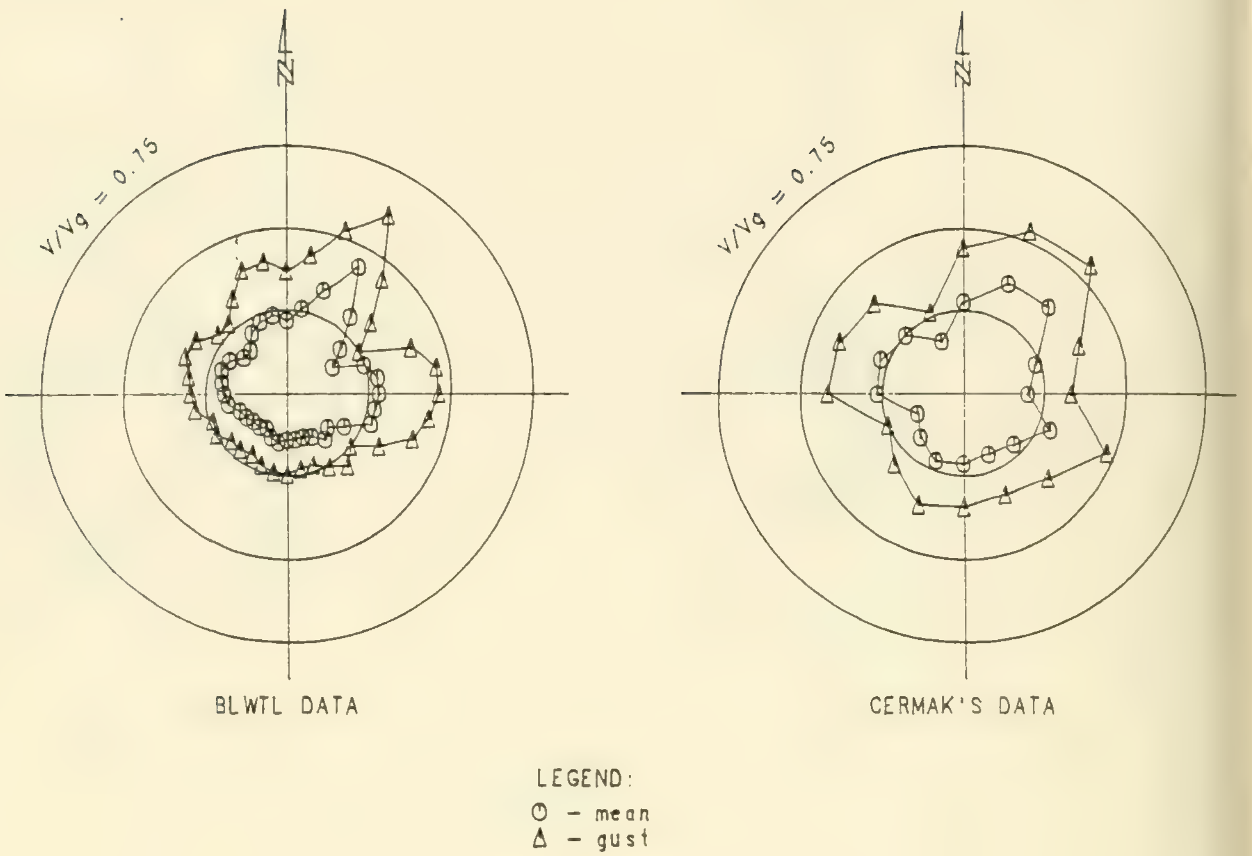
WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 13



WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 15



WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 19

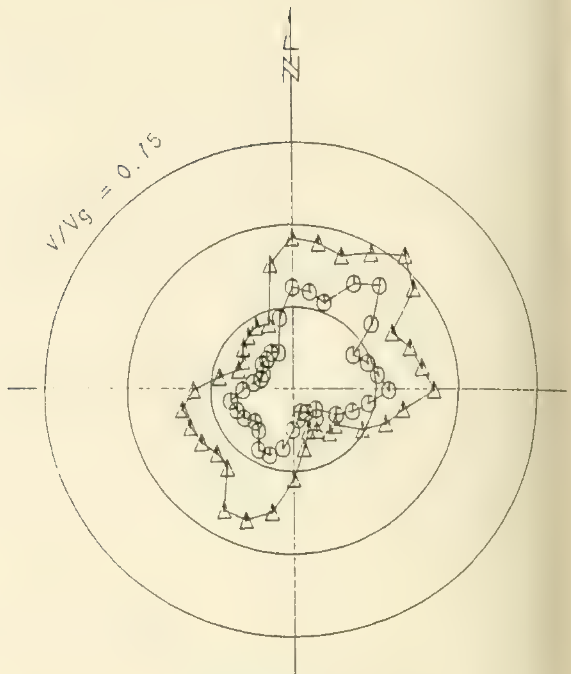


WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 35

APPENDIX B-6

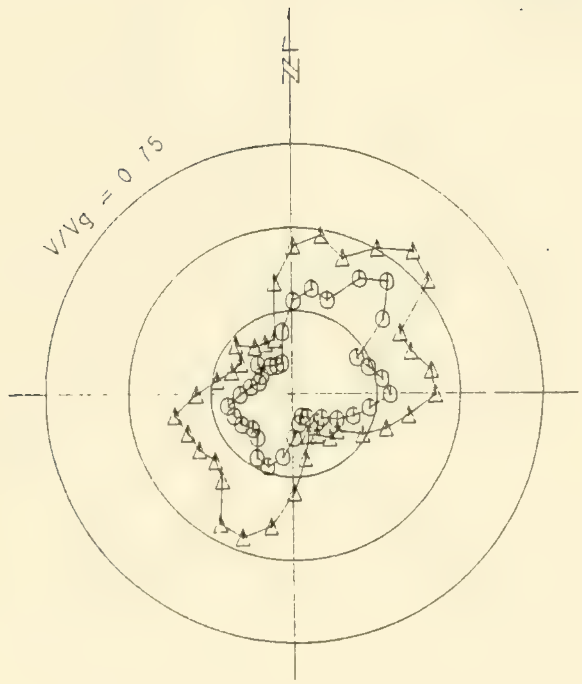
POLAR PLOTS OF MEAN AND GUST WIND SPEEDS

Note: For each gradient wind direction, the plots represent the fraction of the gradient wind speed expected at ground level. Each plot shows both the mean speed and an effective gust speed, defined as gust = mean + 1.5 RMS. This particular definition leads to a gust speed to which humans are expected to be sensitive.



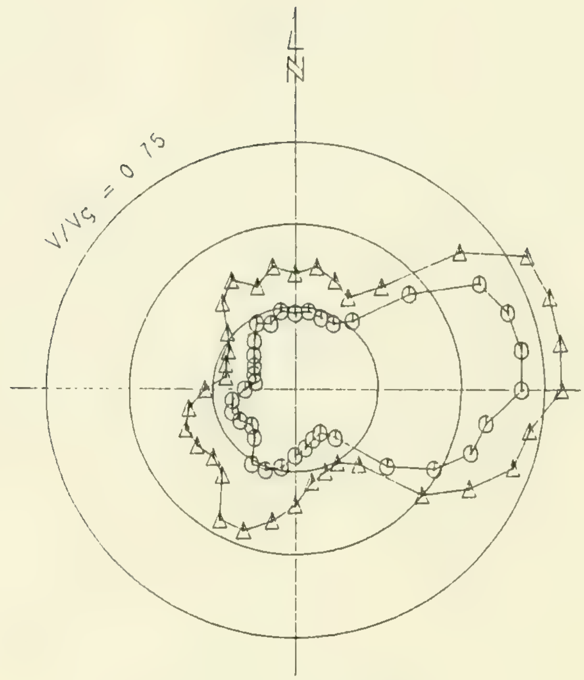
30-STOREY TOWER

LEGEND
O - mean
Δ - gust



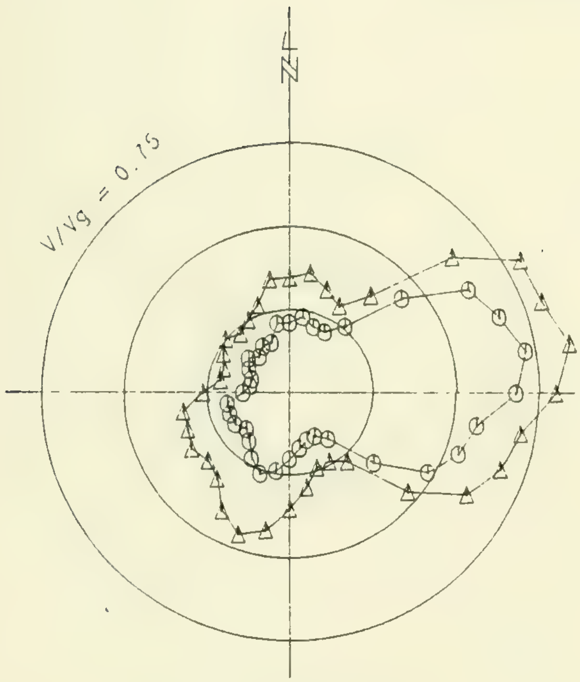
FULL DEVELOPMENT

WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 1



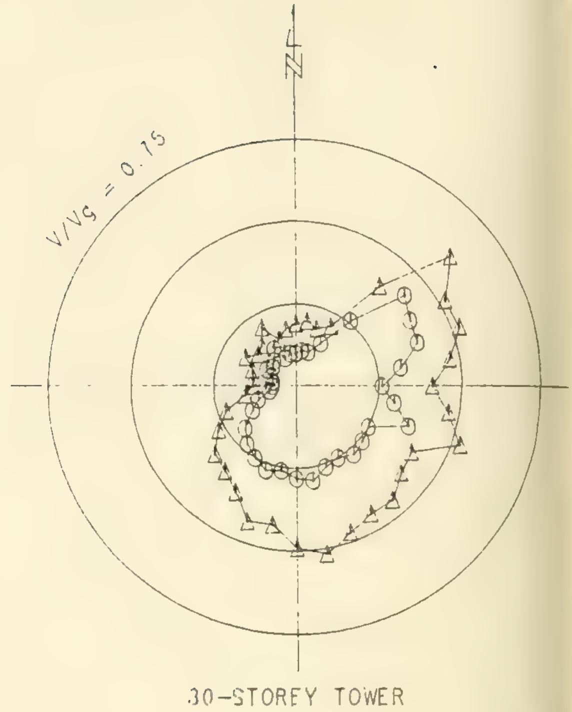
30-STOREY TOWER

LEGEND.
O - mean
Δ - gust

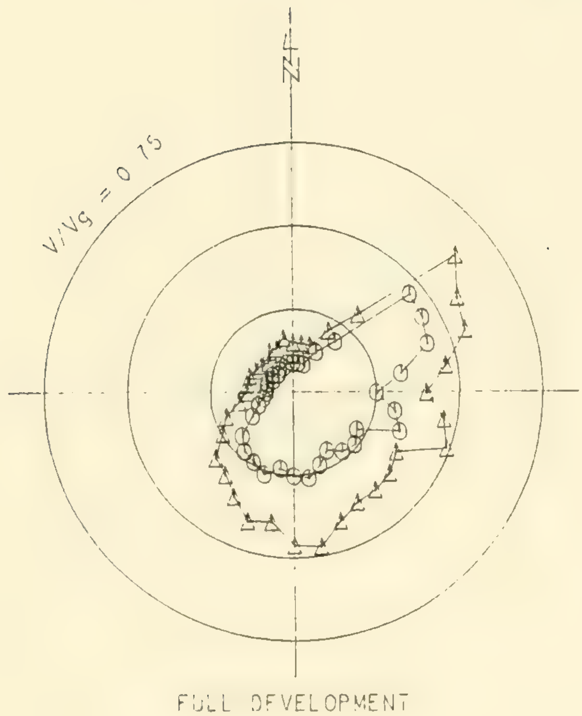


FULL DEVELOPMENT

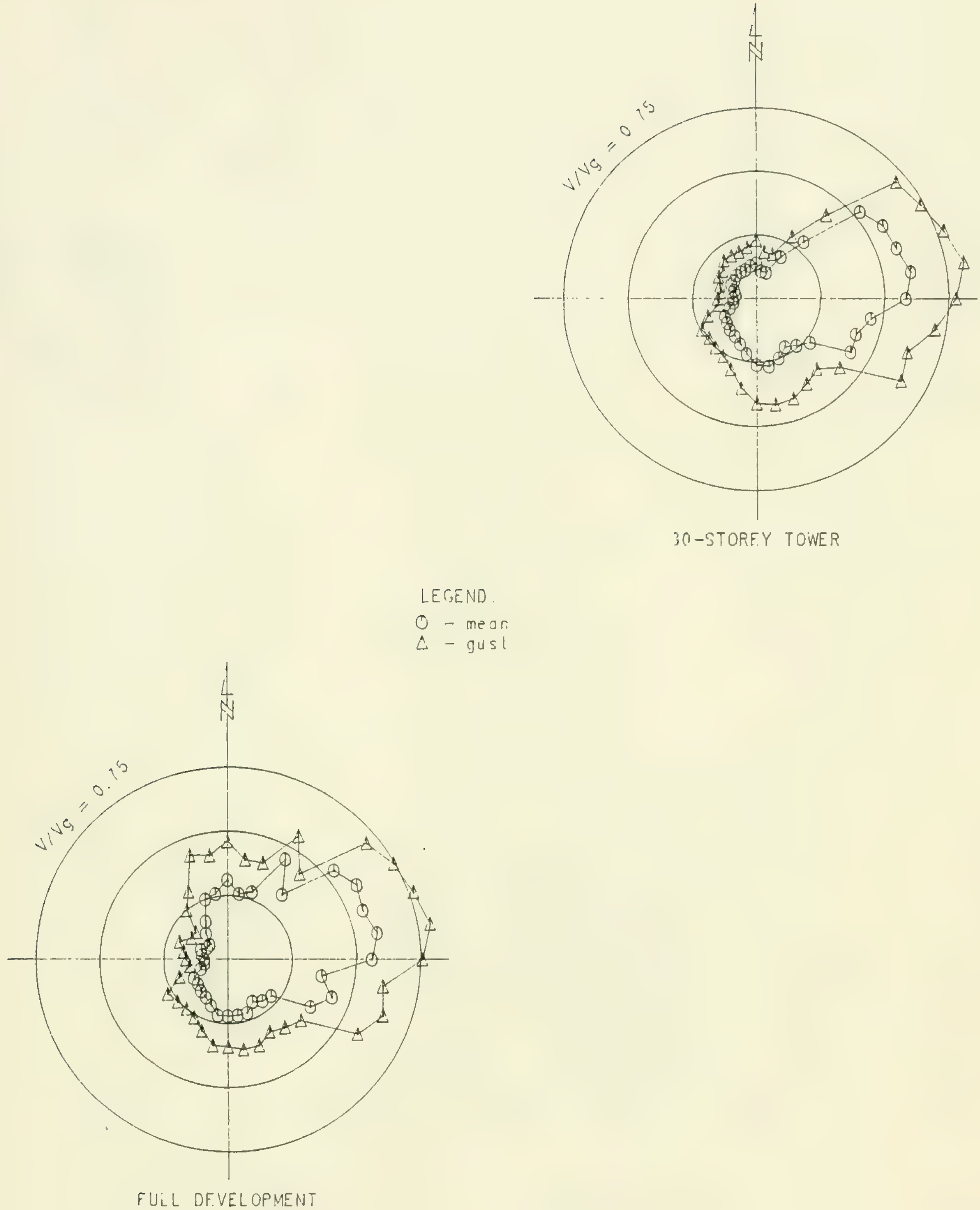
WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 2



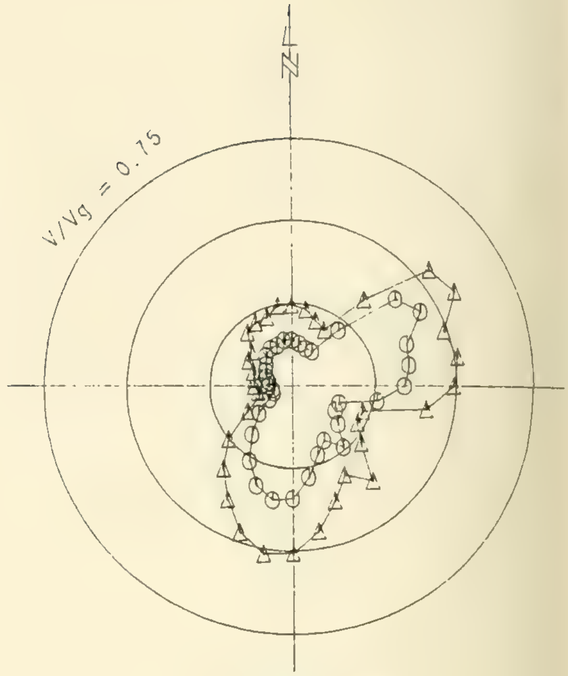
LEGEND
○ - mean
△ - gust



WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 4

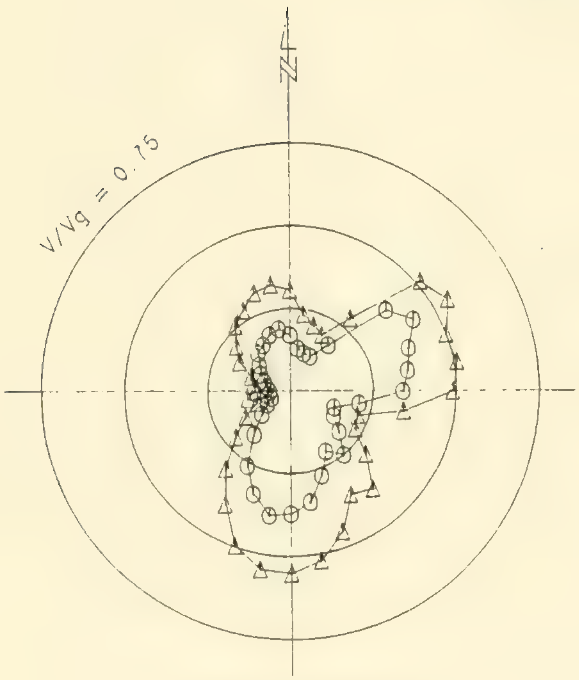


WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 5



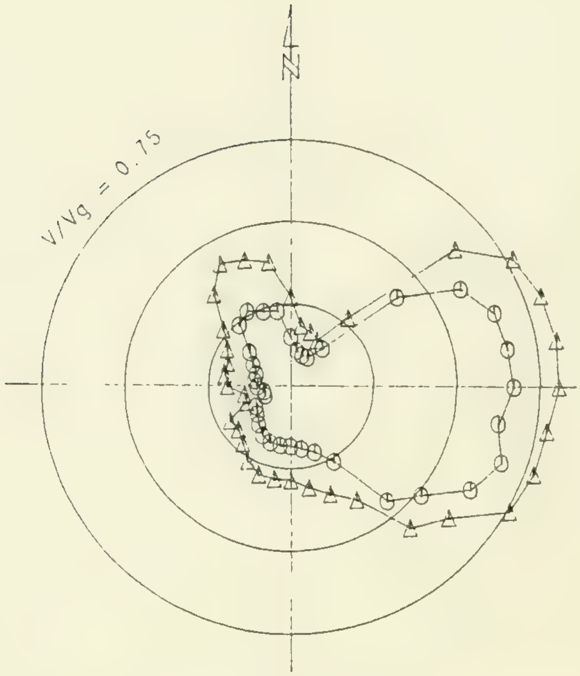
30-STOREY TOWER

LEGEND
○ - mean
△ - gust



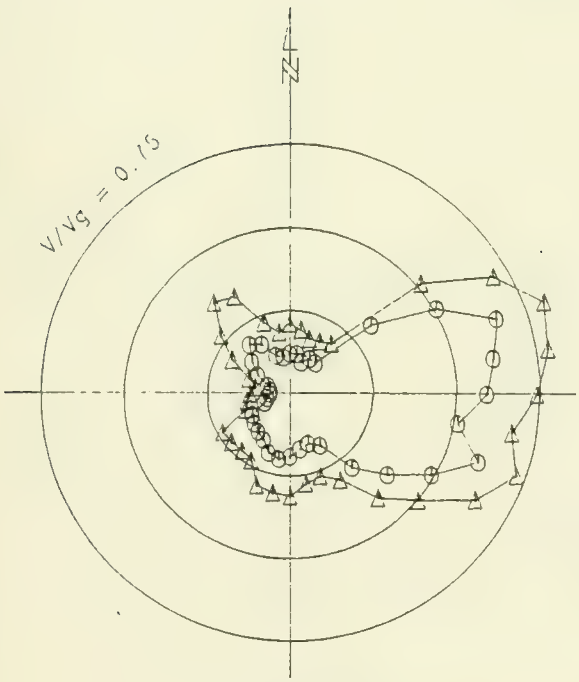
FULL DEVELOPMENT

WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 6



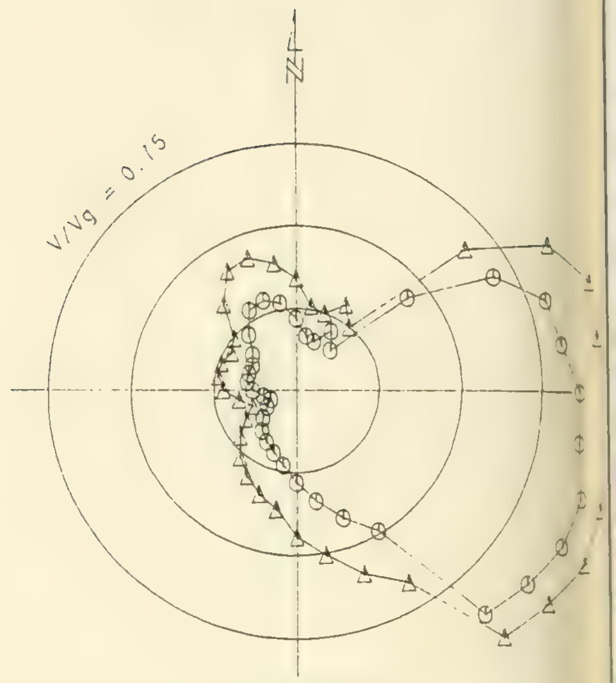
30-STOREY TOWER

LEGEND.
O - mean
Δ - gust



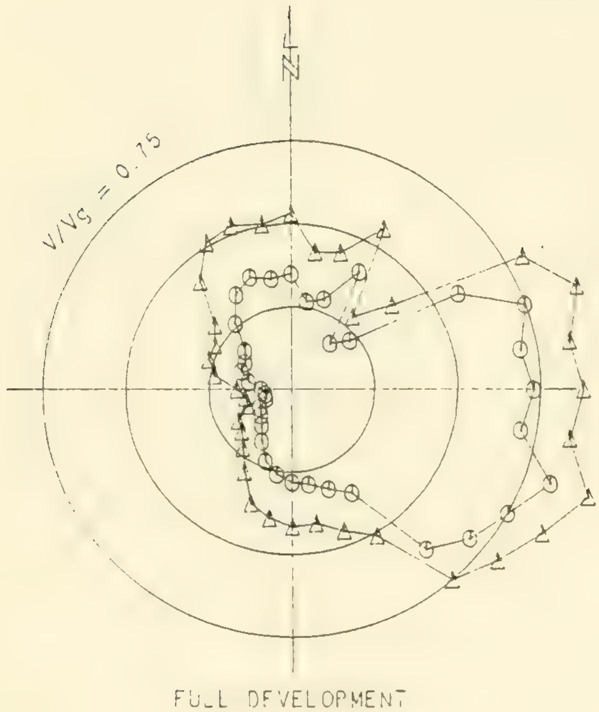
FULL DEVELOPMENT

WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 7



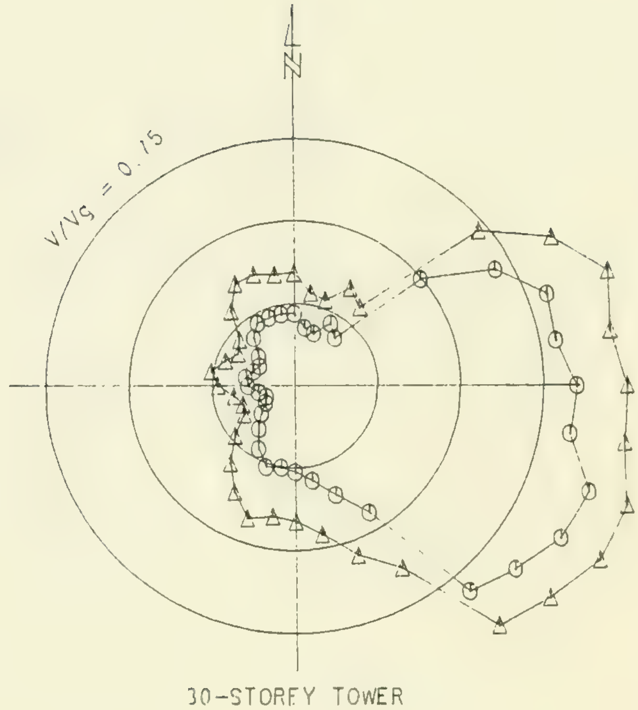
30-STOREY TOWER

LEGEND:
○ - mean
△ - gust

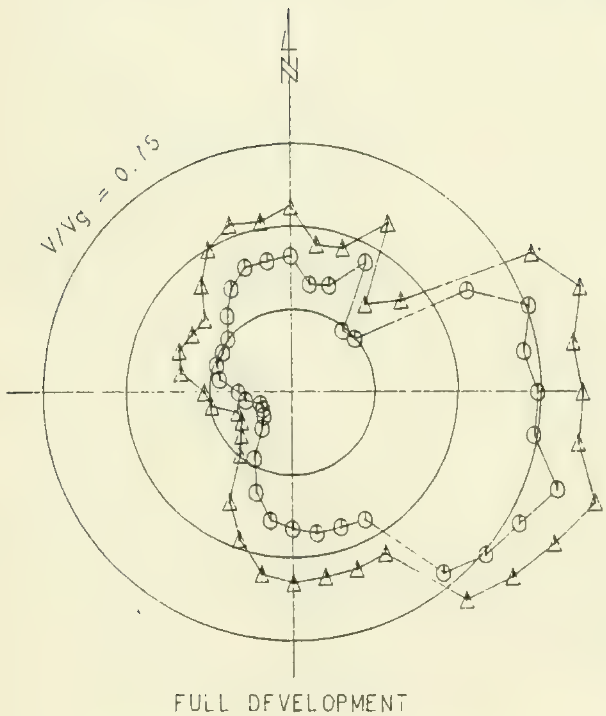


FULL DEVELOPMENT

WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 8



LEGEND:
O - mean
Δ - gust



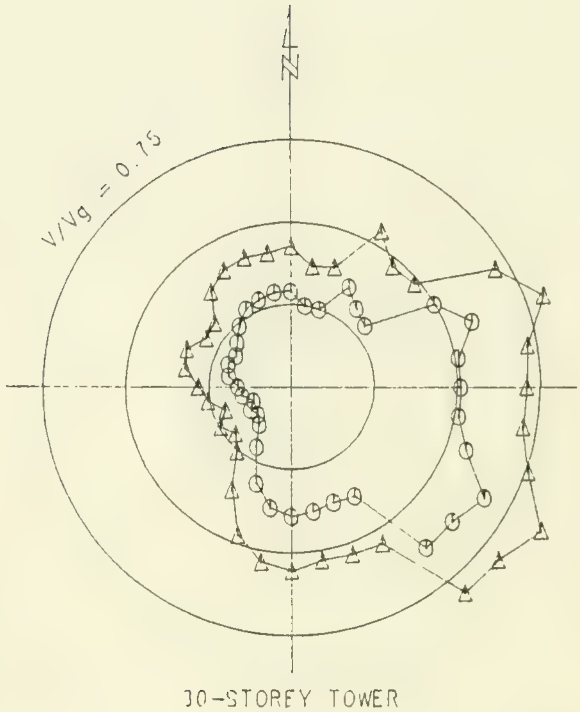
WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 9

WORKSHEET 2 - LINE SOURCE EMISSION RATE COMPUTATION

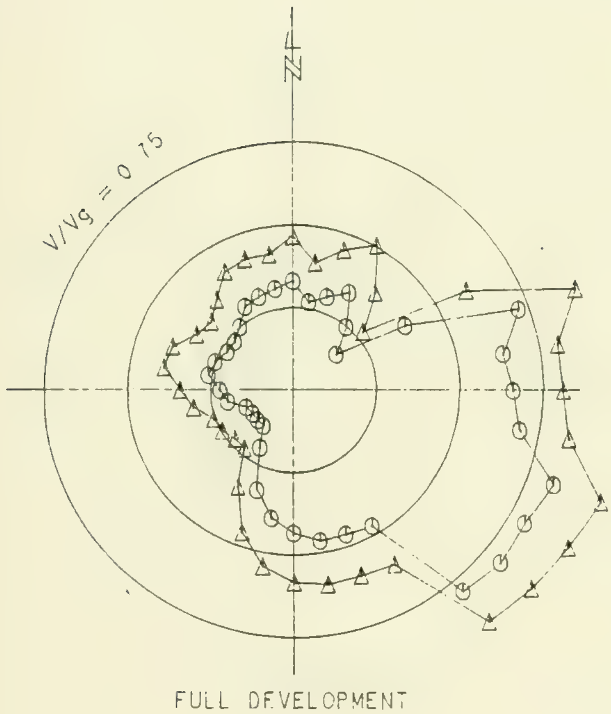
Intersection Purchase / Congress

Case # 1 Year 1986 Averaging Time 8 Hour

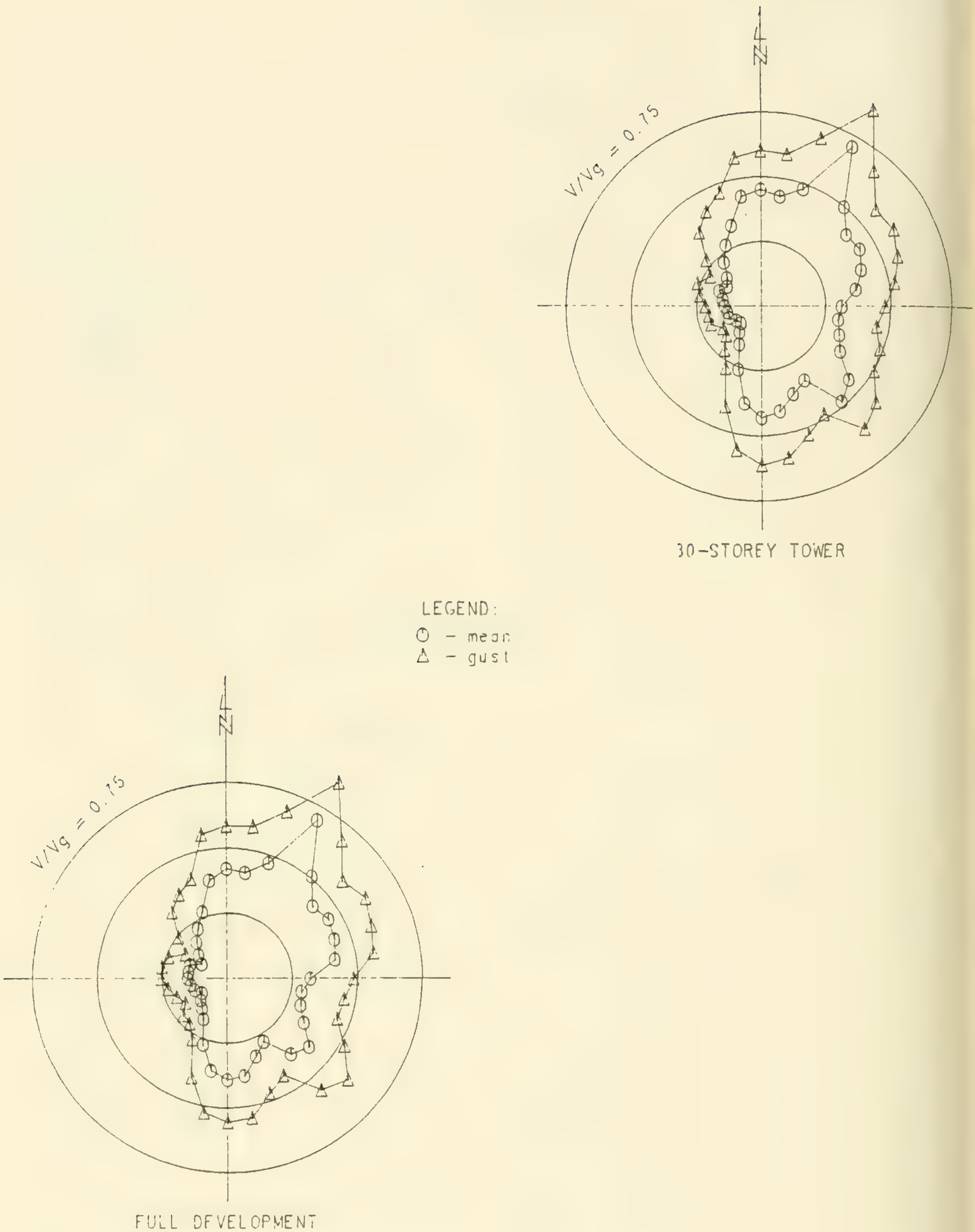
Step	Symbol	Input/Units	Traffic Stream			
1	i	Road segment (or approach identification)	PSL	PSS	CE	
2	V_i	Demand volume (vph)	465	476	792	
3	C_i	Free-flow capacity (vph)				
4	S_i	Cruise speed (mph)	25	25	25	
5	Ef_i	Free-flow emissions (g/veh-m)				
6.1	M_i	Number of lanes in approach i	1	2	4	
6.2	j	Signalized intersections phase identification	ØD	ØB	ØC	
6.3	$Cs_{i,j}$	Capacity service volume of approach i for phase j (vph of green)	3400	4100	7000	
6.4	$V_{i,j}$	Demand volume for approach i, phase j (vph)	465	476	792	
6.5	C_y	Signal cycle length (s)	70			
6.6	$G_{i,j}$	Green phase length for approach i, phase j (s)	52	36	38	
6.7	C_i	Capacity of approach i·(vph))	1964	1640	2956	
6.8	$P_{i,j}$	Proportion of vehicles that stop	0.49	0.68	0.65	
6.9	$N_{i,j}$	Number of vehicles that stop per signal cycle	5.69	8.08	12.9	
7	N_i	Average number of vehicles in queue at four way stop or two-way stop or end of green phase	0.31	0.41	0.37	
8	Lq_i	Length of vehicle queue for approach i (veh-m/lane)	36.0	25.5	19.9	
9	Rq_i	Average excess running time on approach (s/veh)				
10	Ea_i	emissions from acceleration (g/veh-m)				
11	Ed_i	emissions from deceleration (g/veh-m)				
12	Qad_i	emission rate from acceleration and deceleration (g/m-s)				
13	Lad_i	Length of acceleration and deceleration (m)				
14	Le_i	Length over which excess emissions apply (m)				
15	Fs_i	Average idling emission rate (g/s)				
16	Qe	Average emission rate (g/m-s)				
17	Qe_i	Adjusted excess emission rate (g/s-m)				
18	Qfc_i	Free-flow emission rate (g/s-m)				



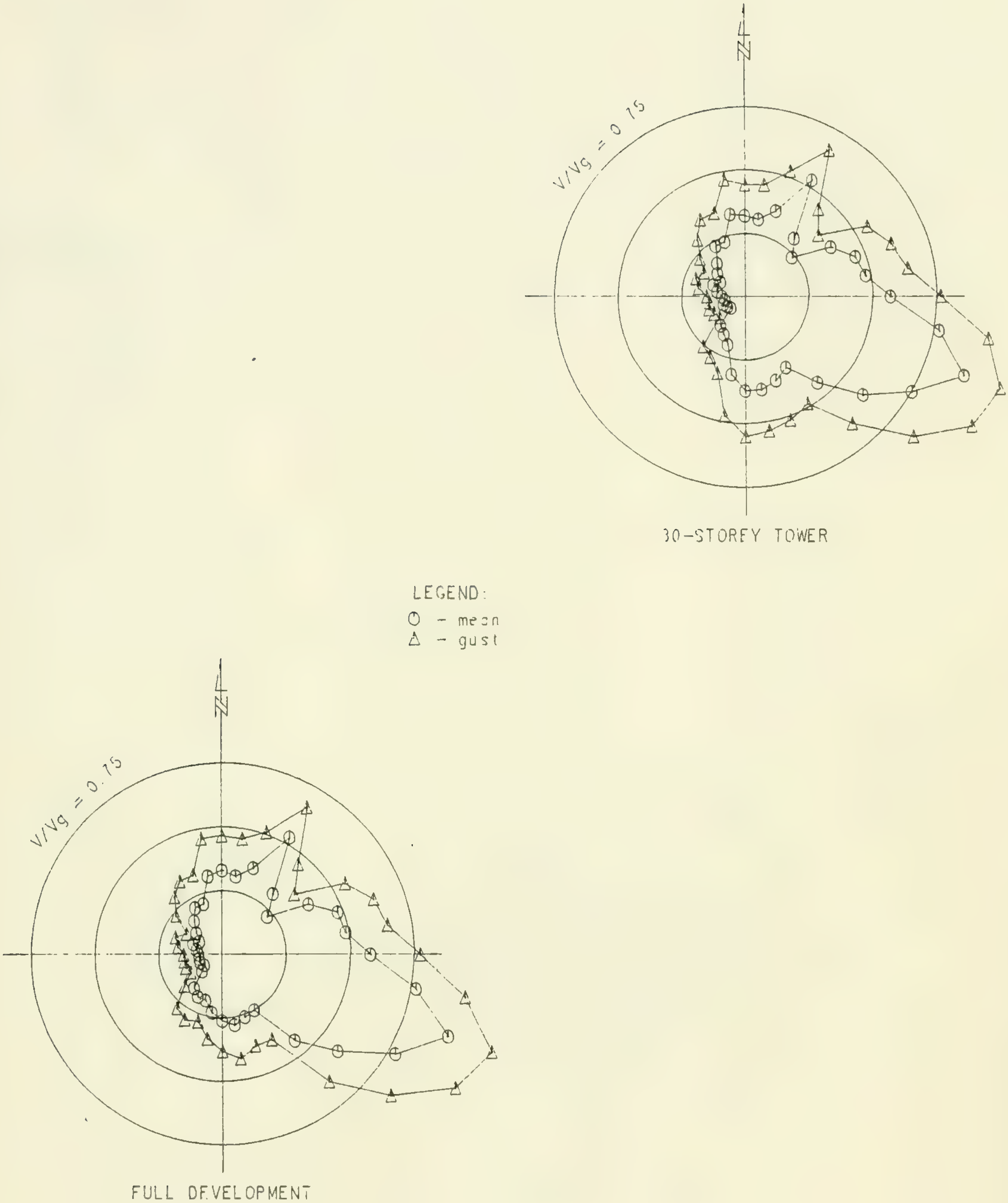
LEGEND
O - mean
Δ - gust



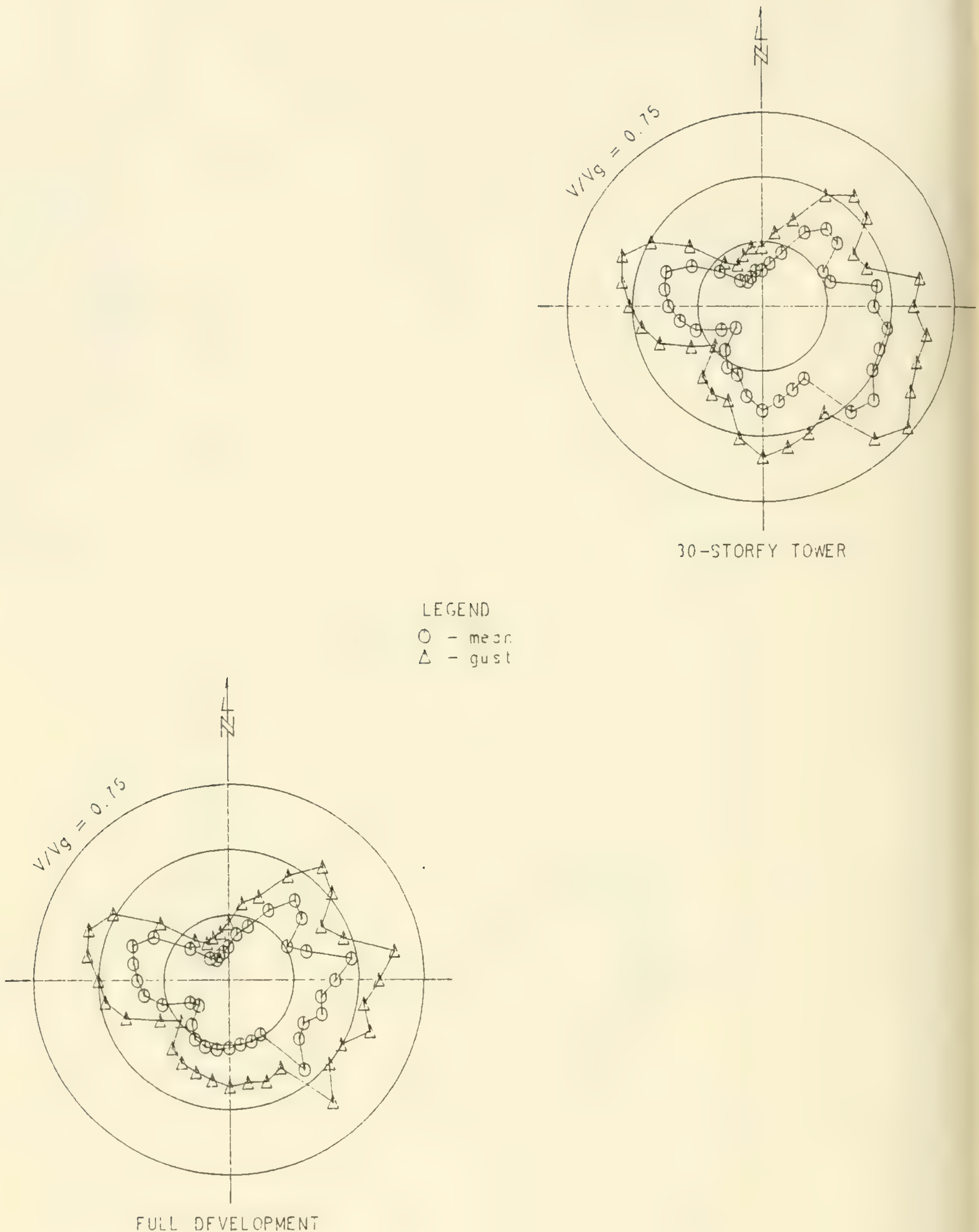
WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 10



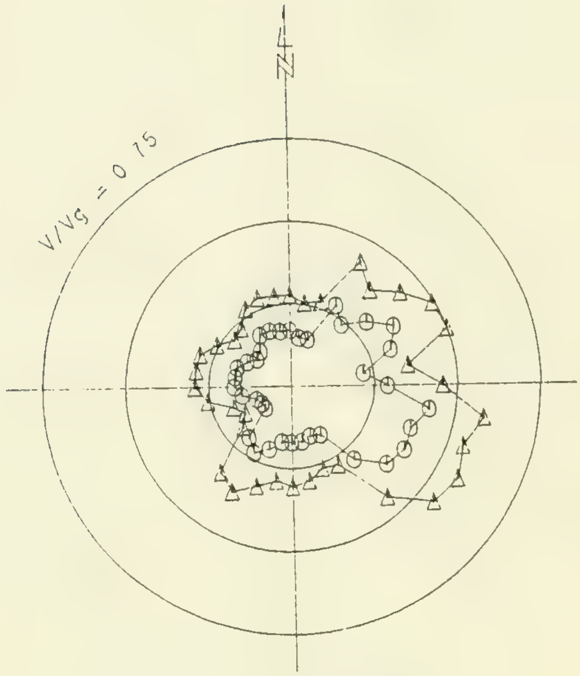
WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 11



WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 12

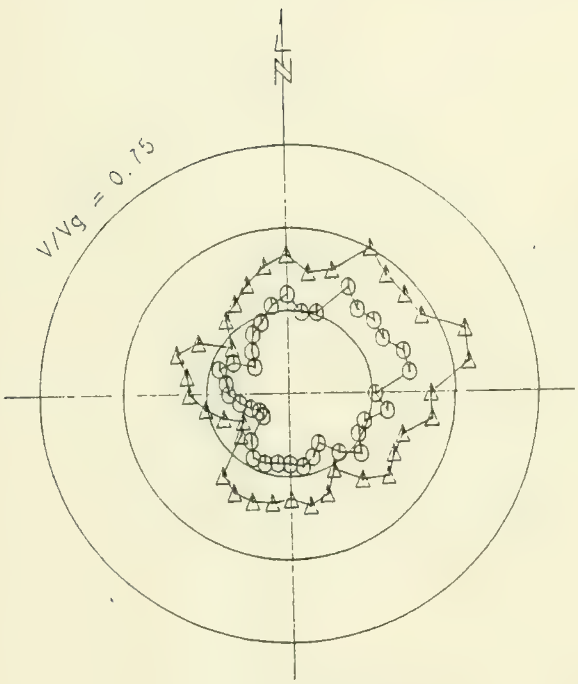


WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 13



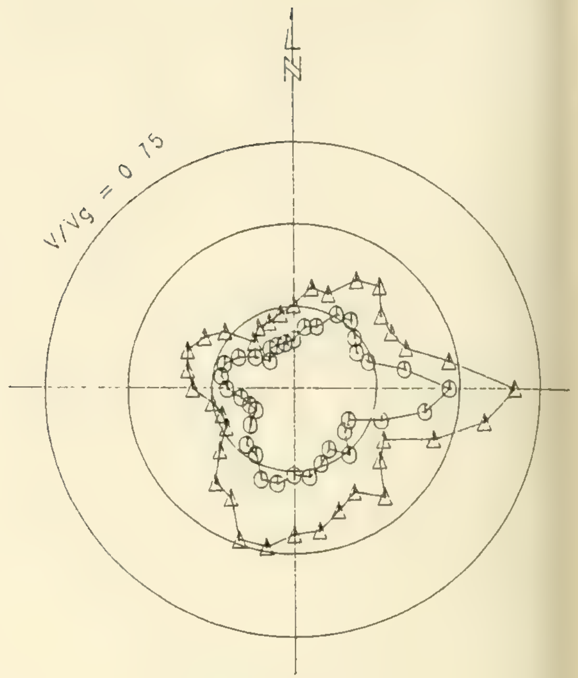
30-STOREY TOWER

LEGEND
O - mean
Δ - gust



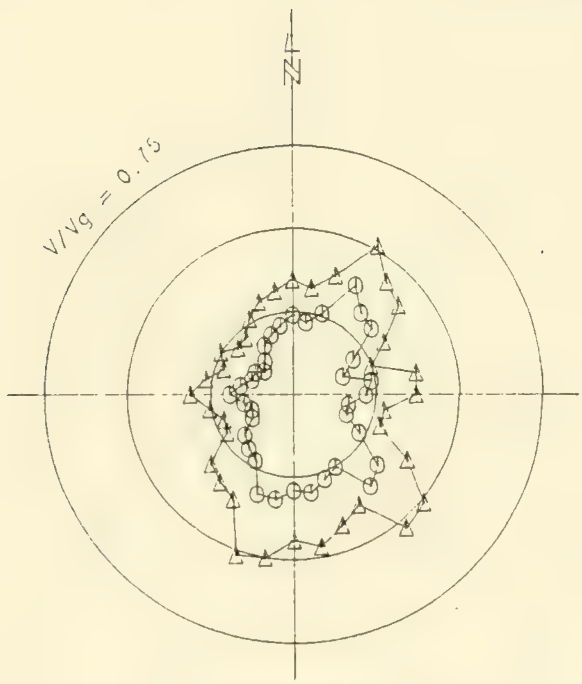
FULL DEVELOPMENT

WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 14



30-STOREY TOWER

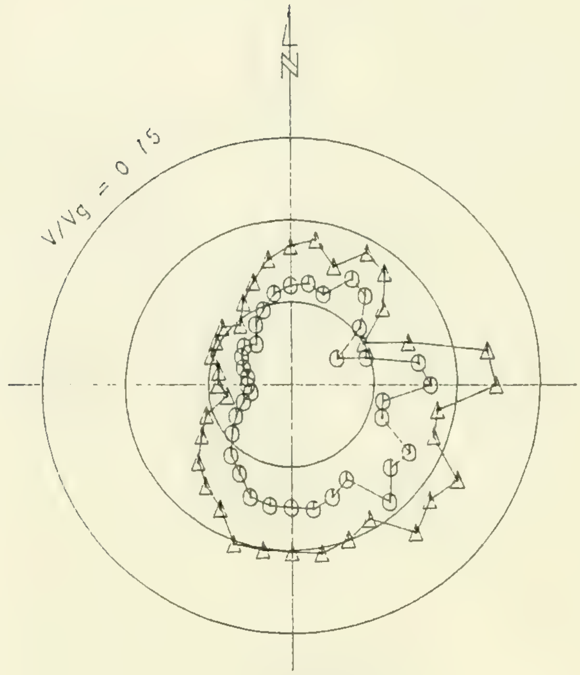
LEGEND.
○ - mean
△ - gust



FULL DEVELOPMENT

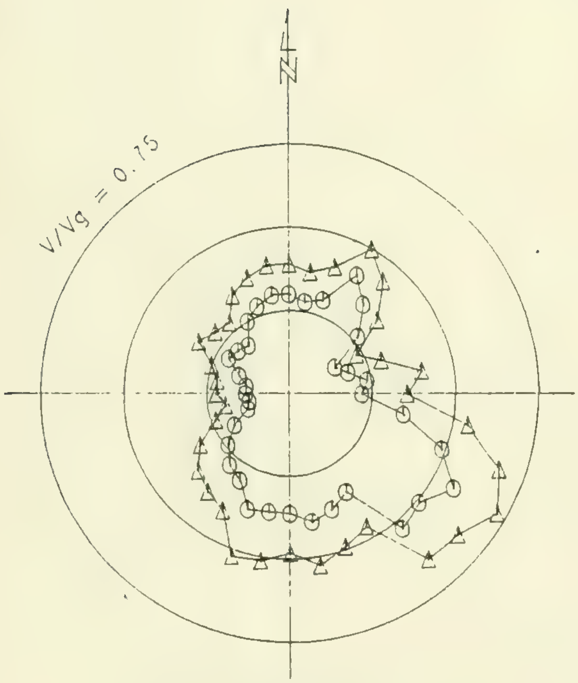
WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS

PROBE LOCATION 17



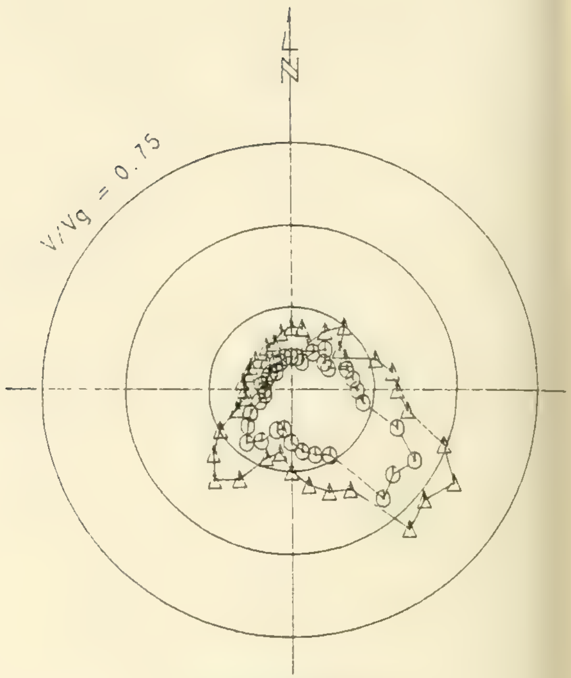
30-STOREY TOWER

LEGEND.
○ - mean
△ - gust



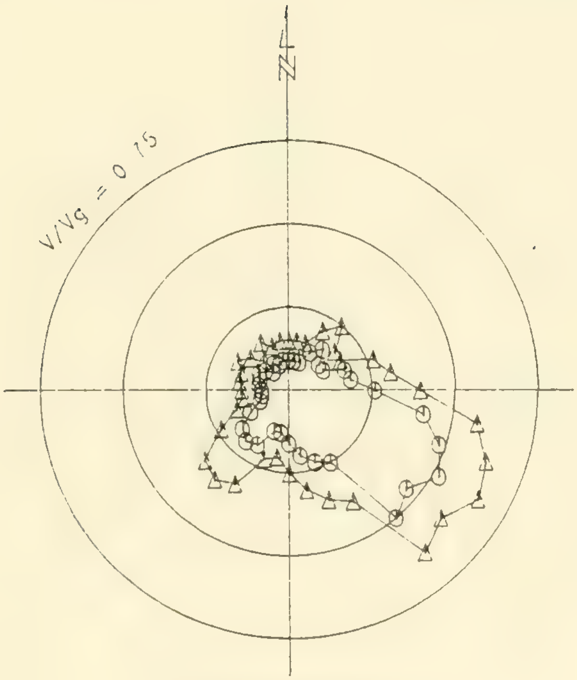
FULL DEVELOPMENT

WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 18



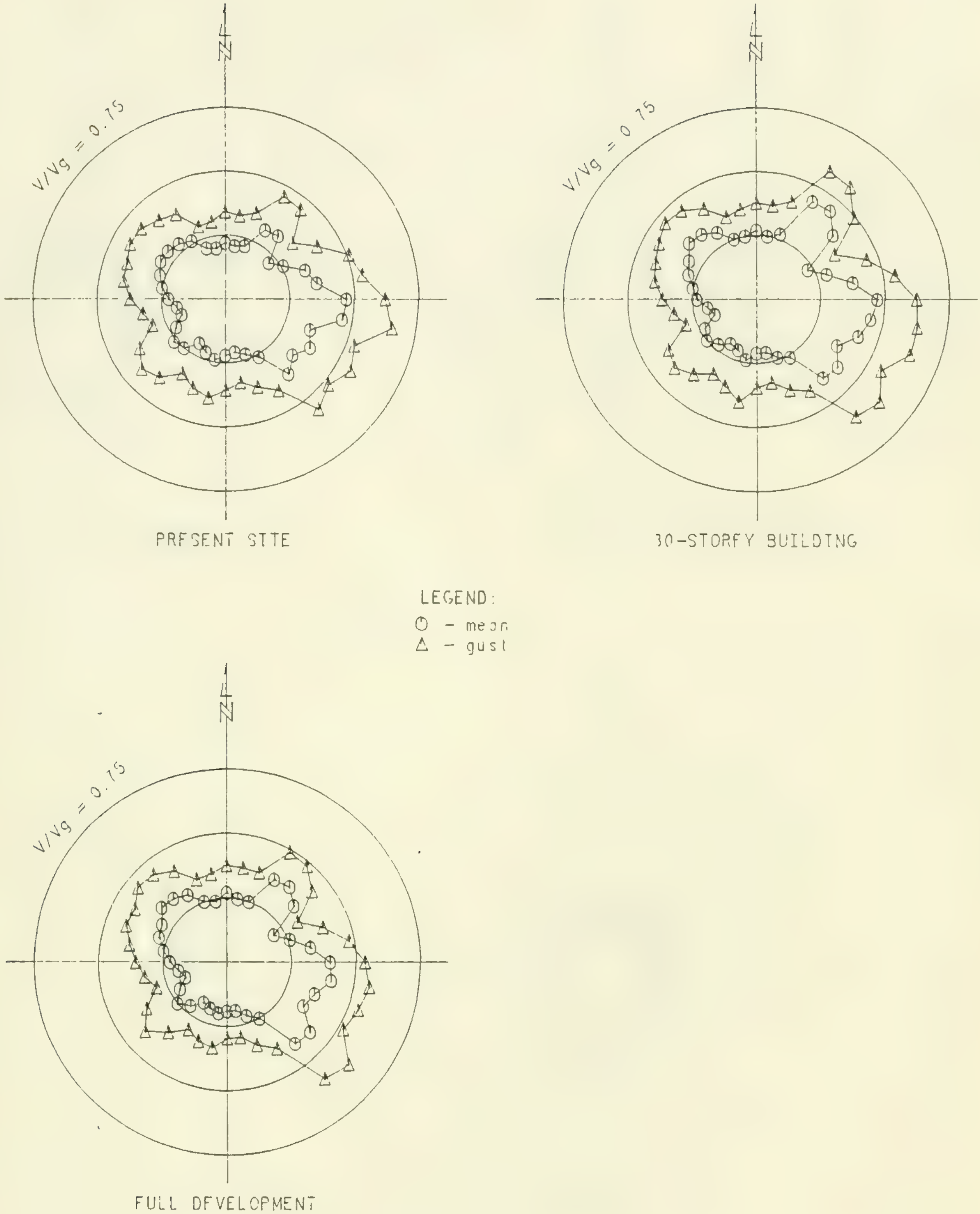
30-STORFY TOWER

LEGEND.
O - mean
Δ - gust

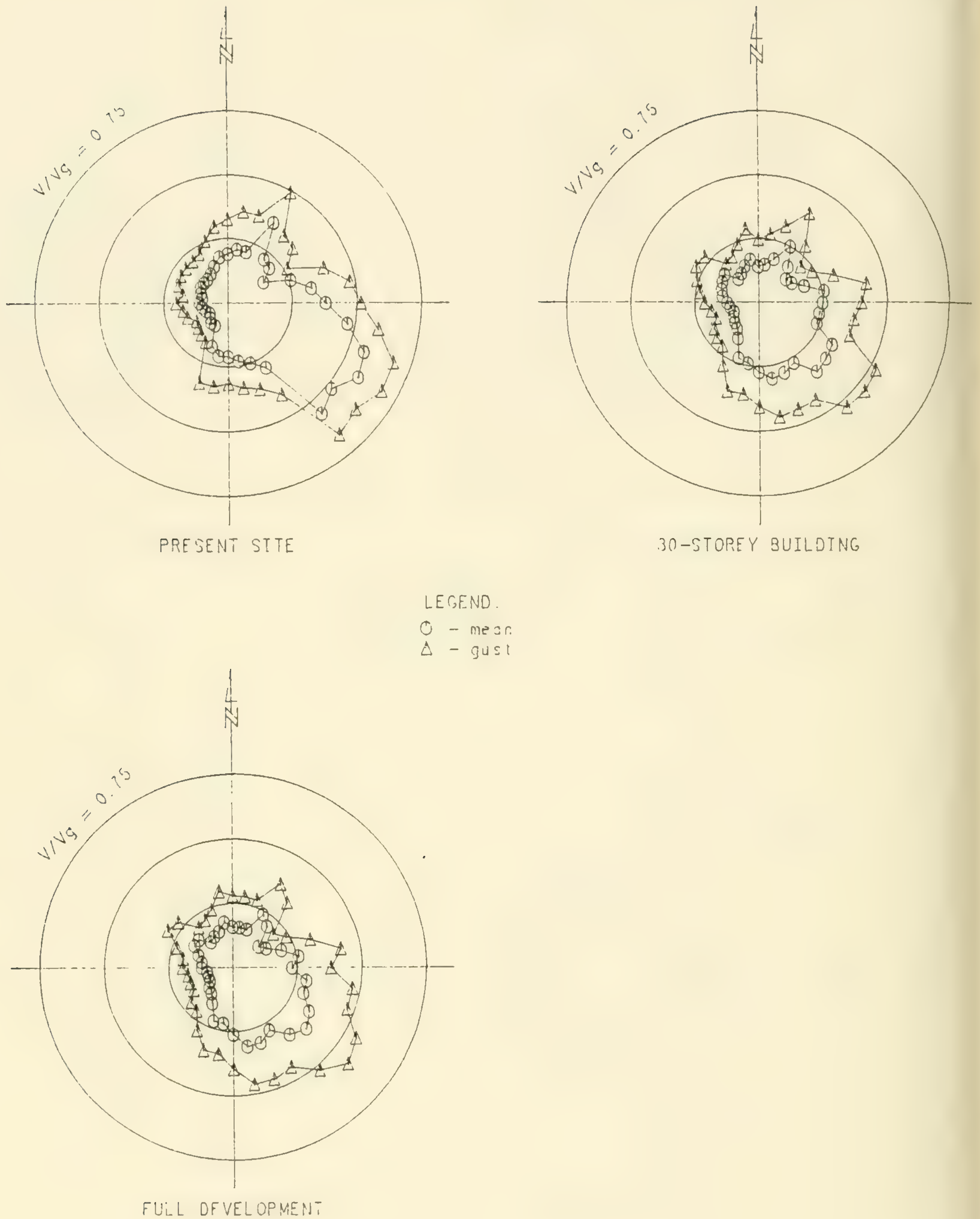


FULL DFVELOPMENT

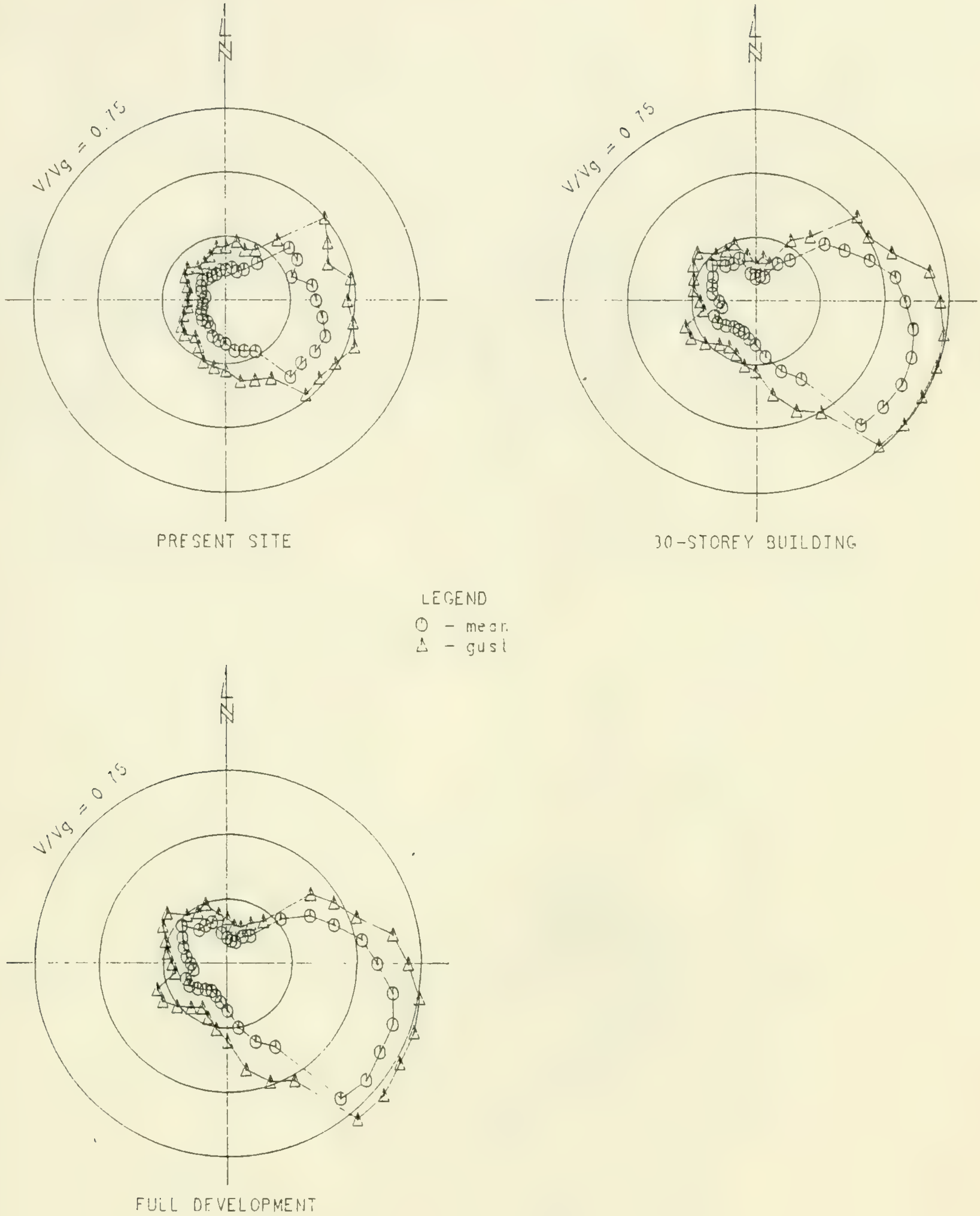
WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 19



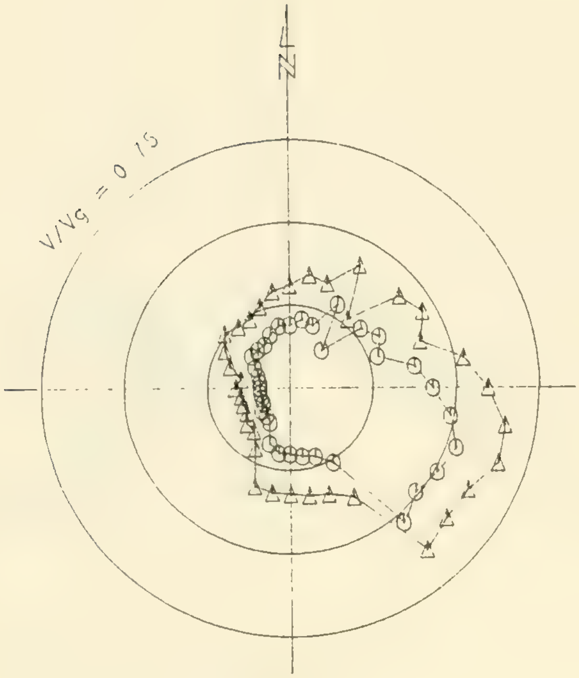
WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 20



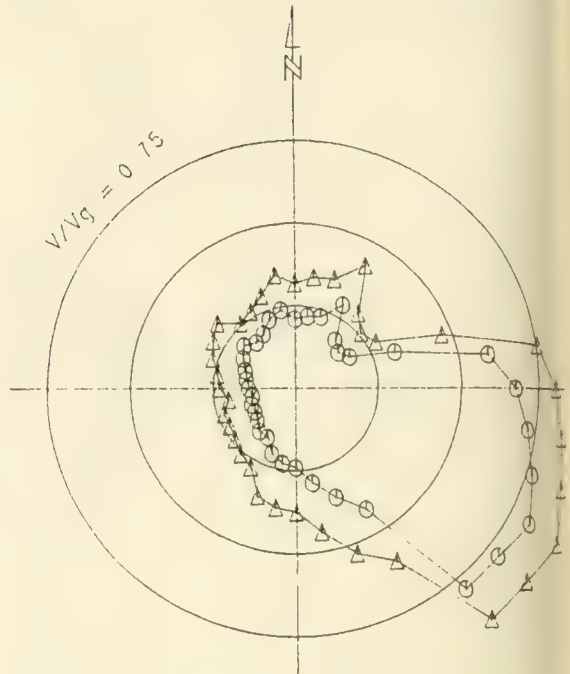
WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 21



WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 23

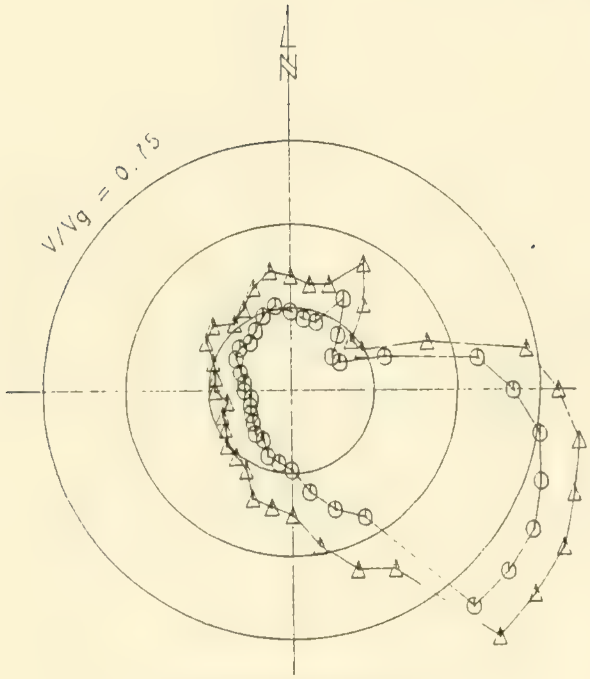


PRESENT SITE



30-STOREY BUILDING

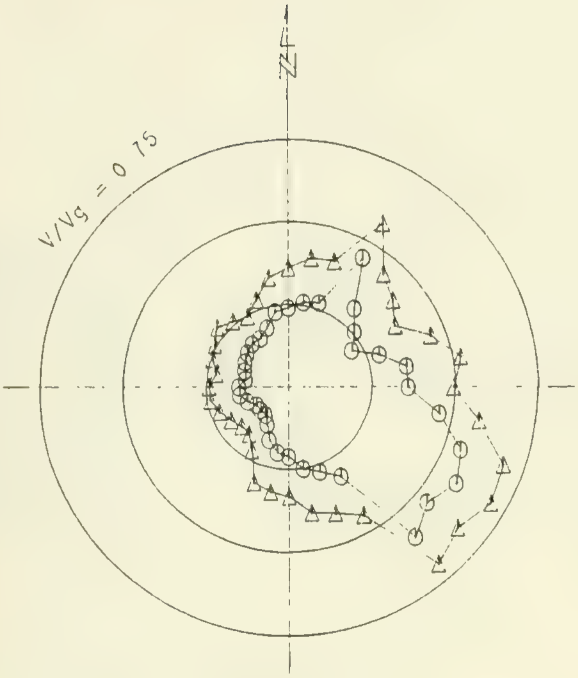
LEGEND
○ - mean
△ - gust



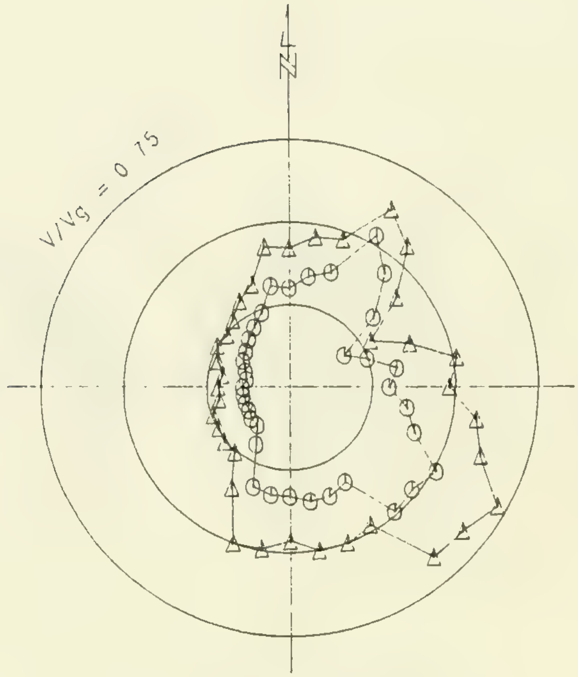
FULL DEVELOPMENT

WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS

PROBE LOCATION 24

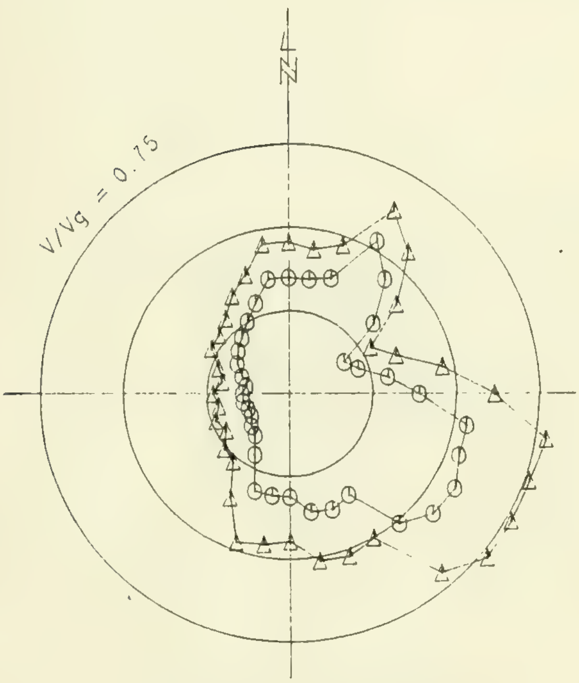


PRESENT SITE



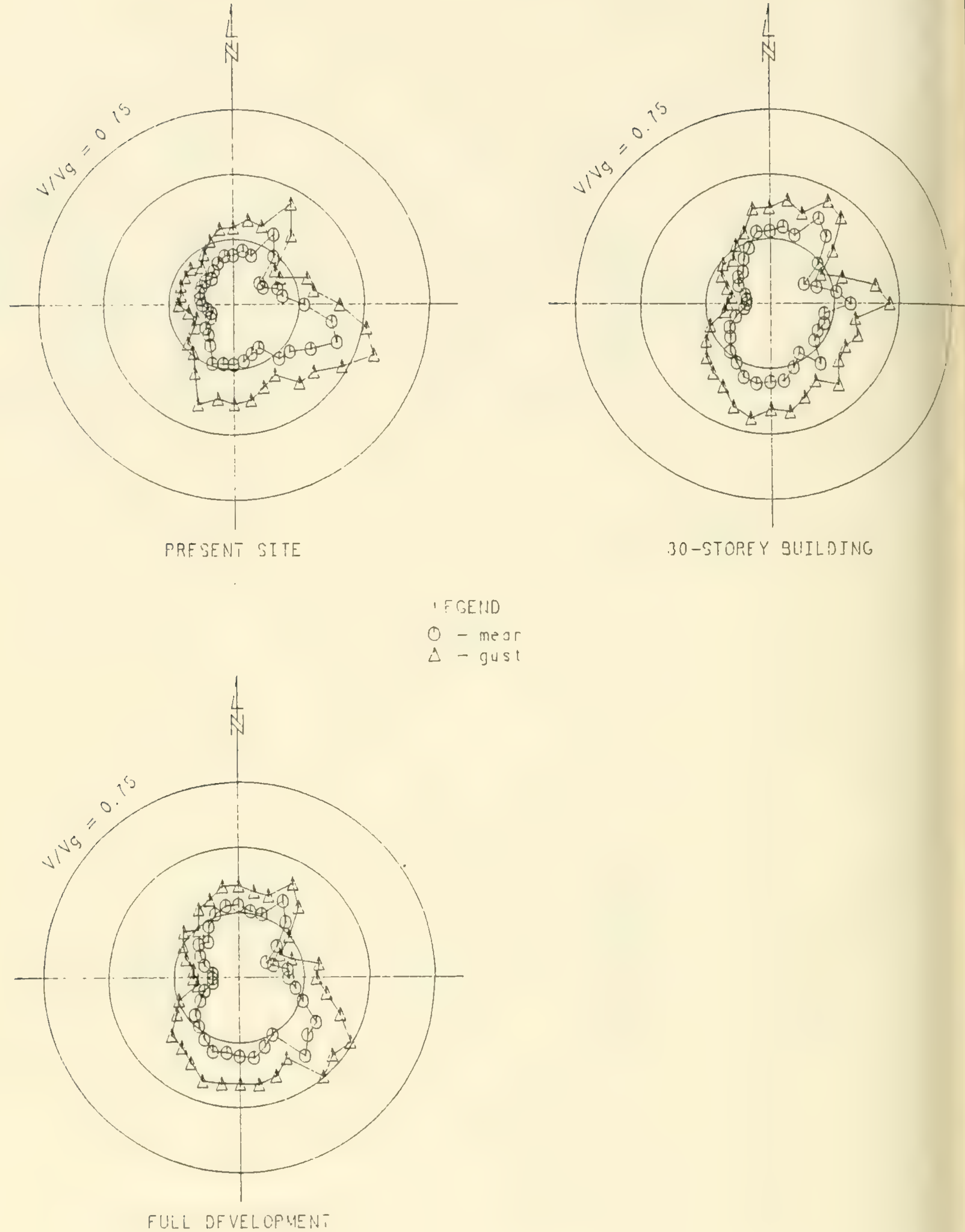
30-STOREY BUILDING

LEGEND.
○ - mean
△ - gust

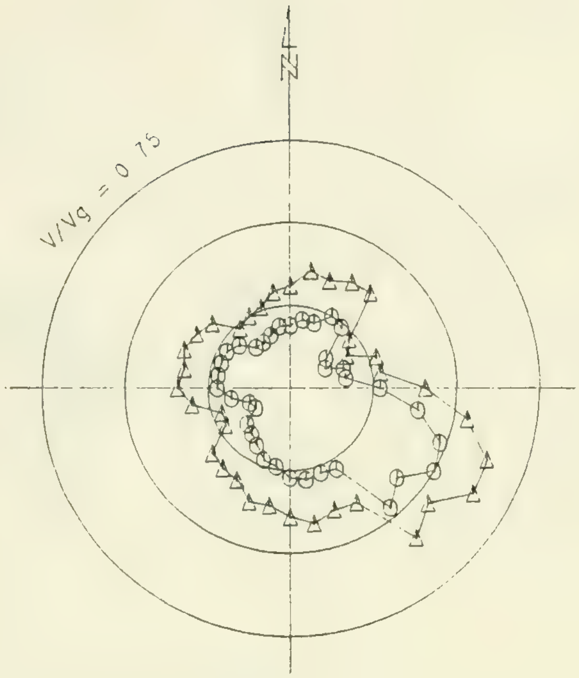


FULL DEVELOPMENT

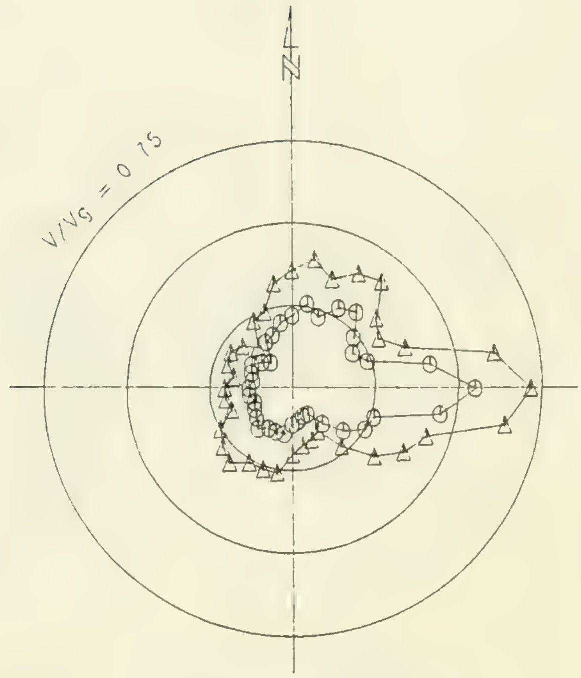
WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 25



WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 26

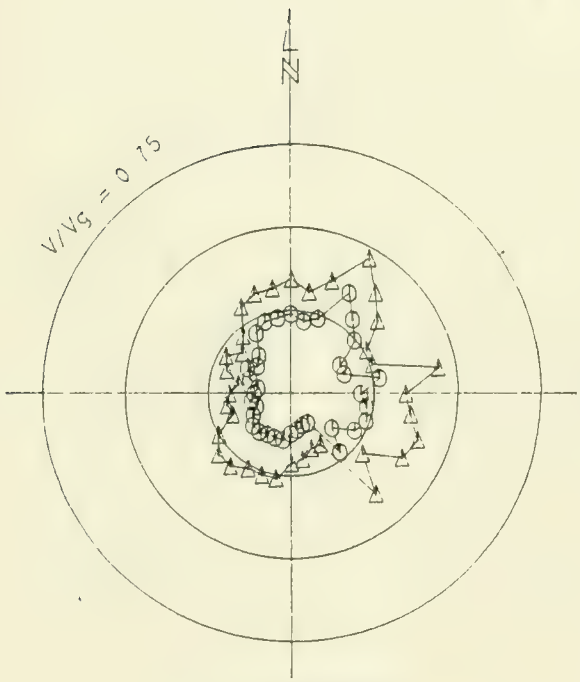


PRESENT SITE



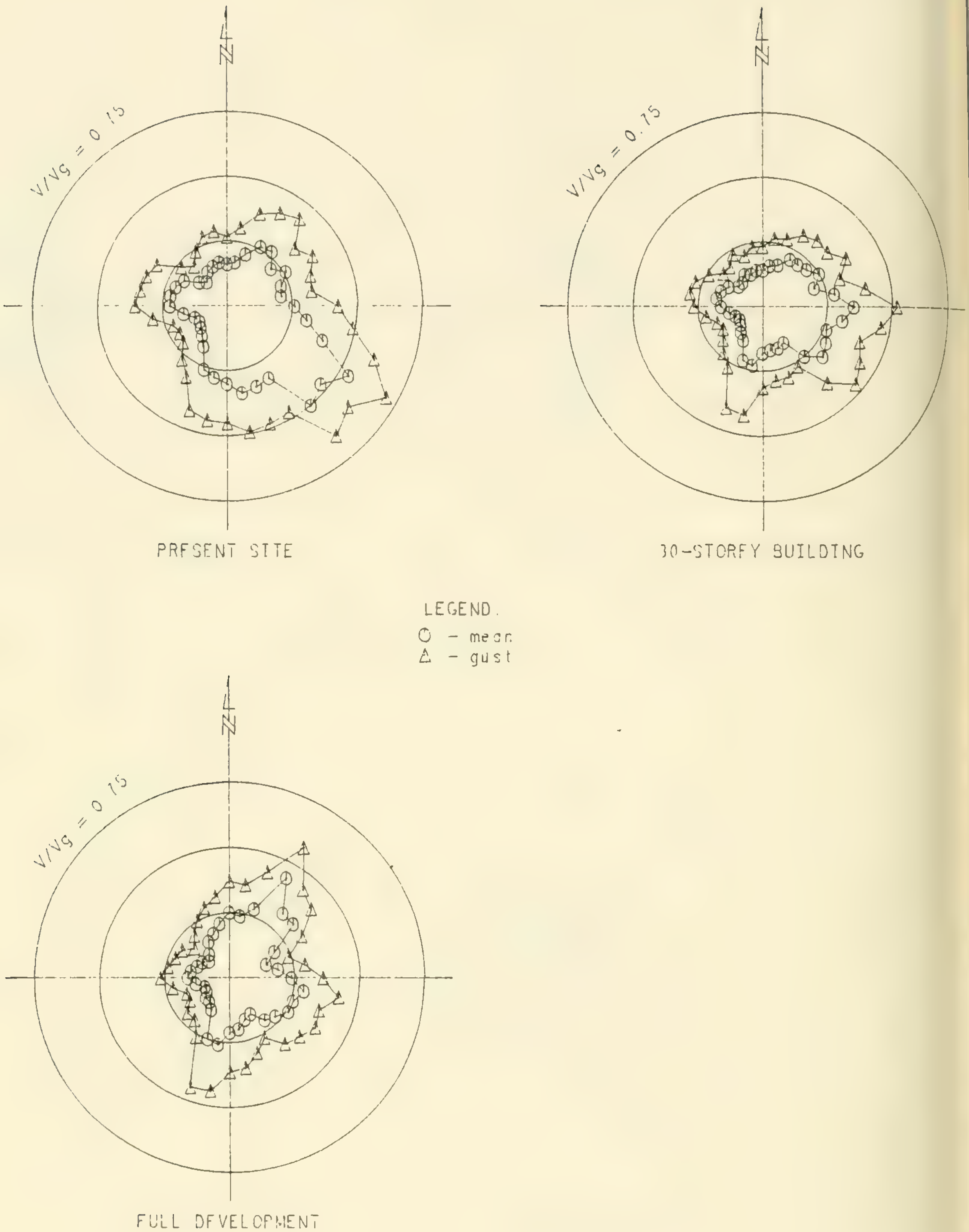
30-STOREY BUILDING

LEGEND:
○ - mean
△ - gust

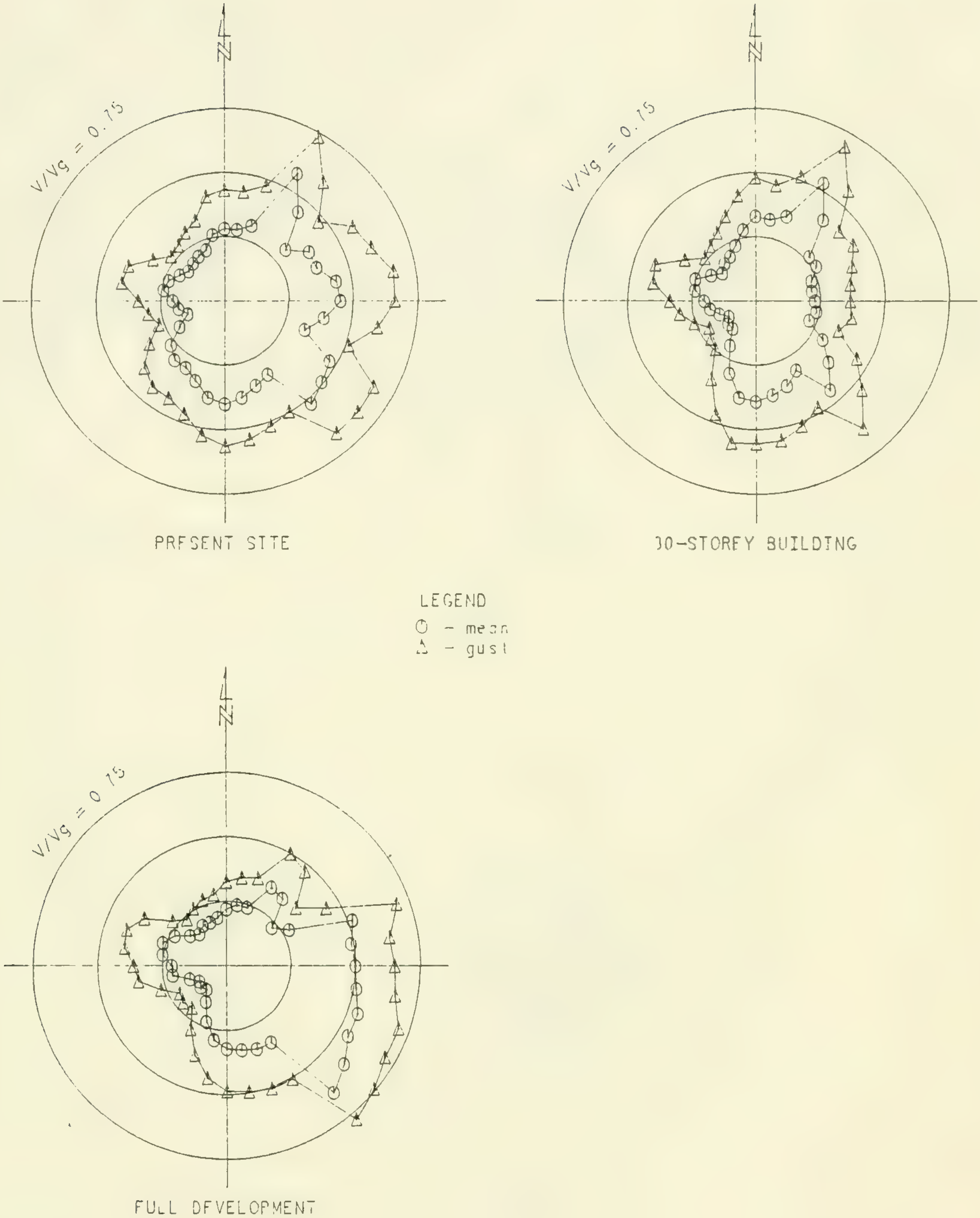


FULL DEVELOPMENT

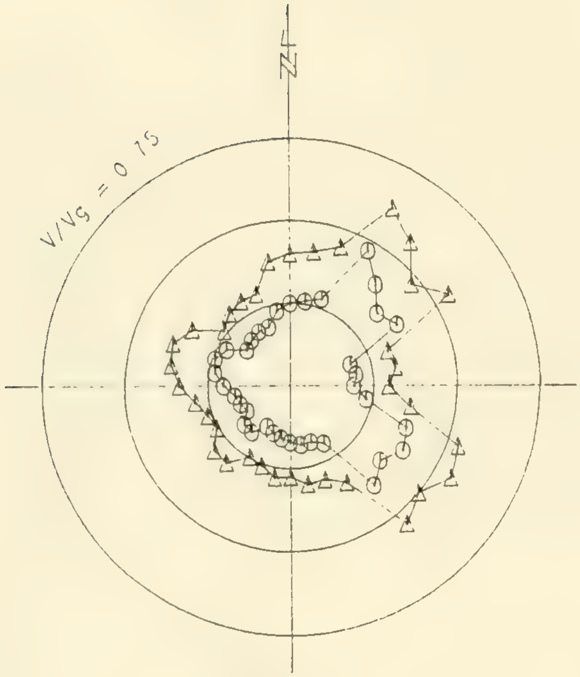
WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 28



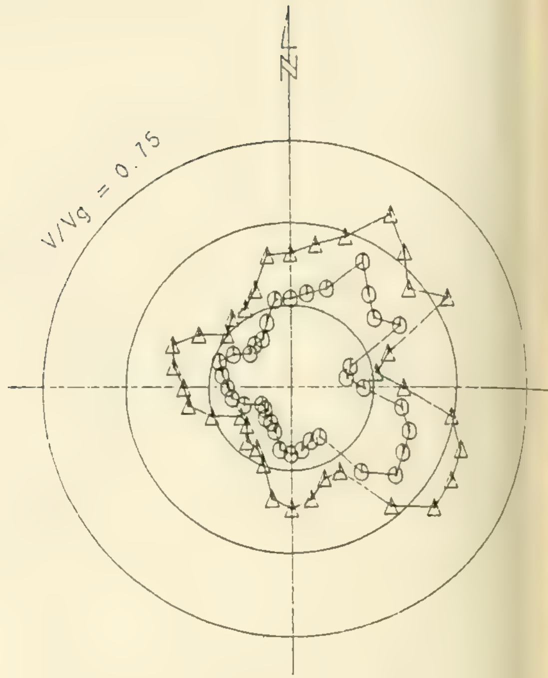
WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 29



WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 30

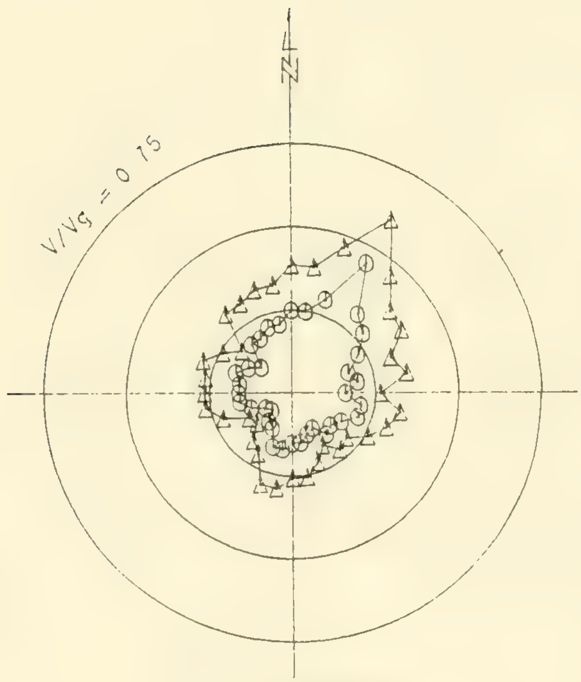


PRESENT SITE



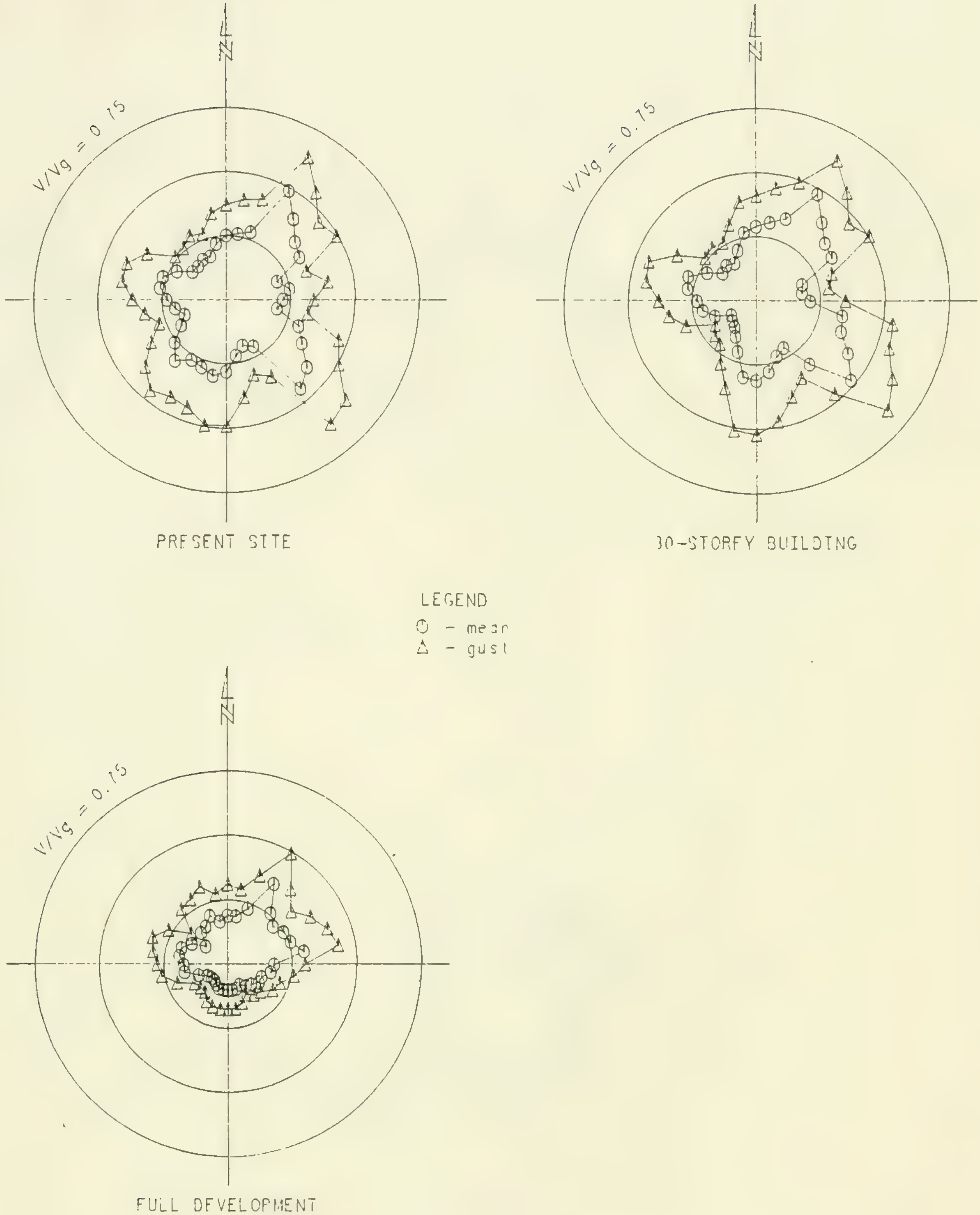
30-STOREY BUILDING

LEGEND
○ - mean
△ - gust

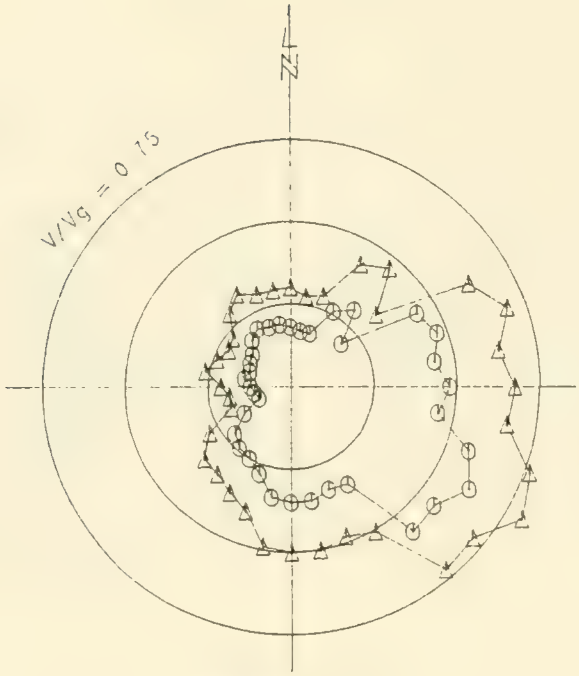


FULL DEVELOPMENT

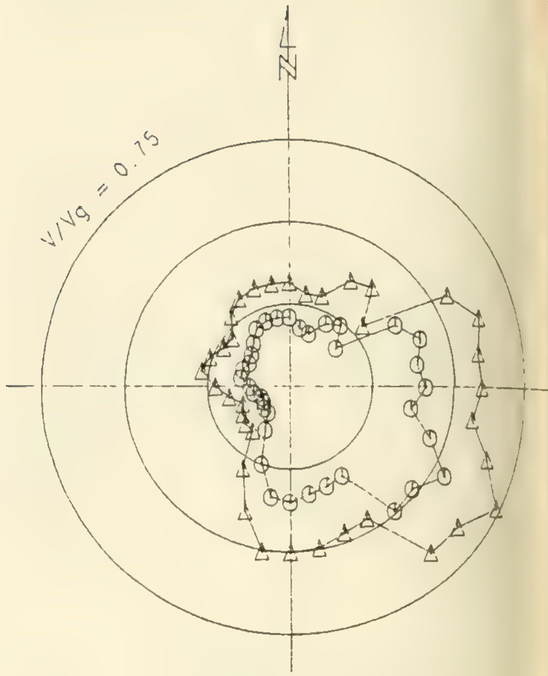
WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 31



WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 36

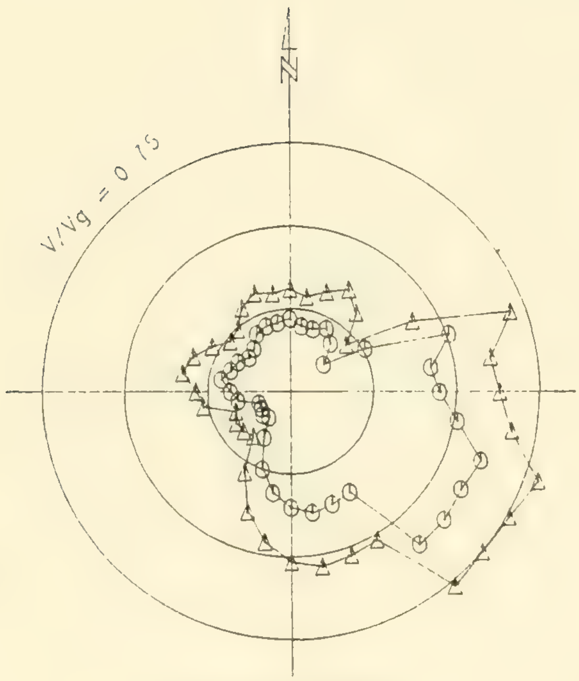


PRESENT SITE



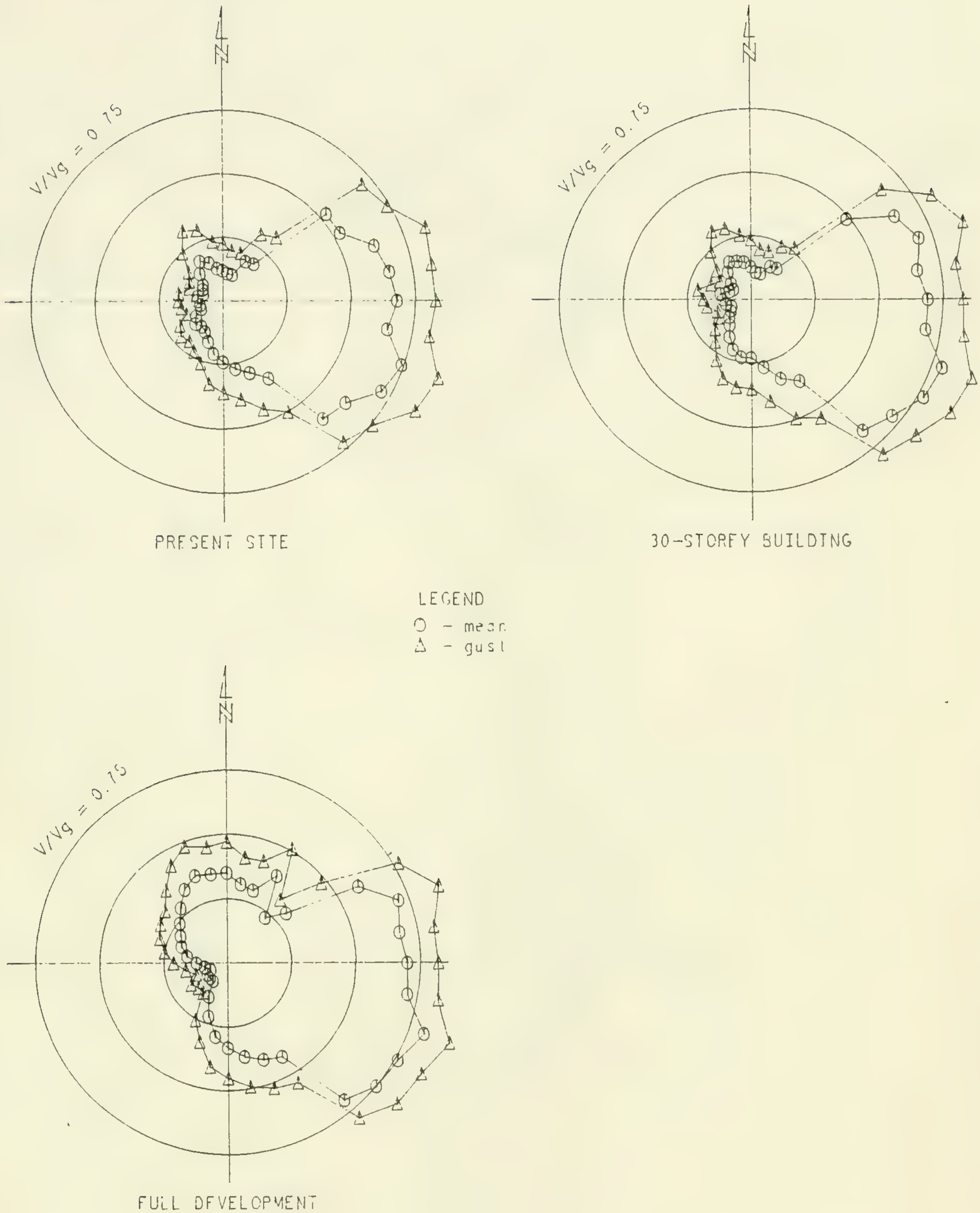
30-STOREY BUILDING

LEGEND
O - mean
Δ - gust

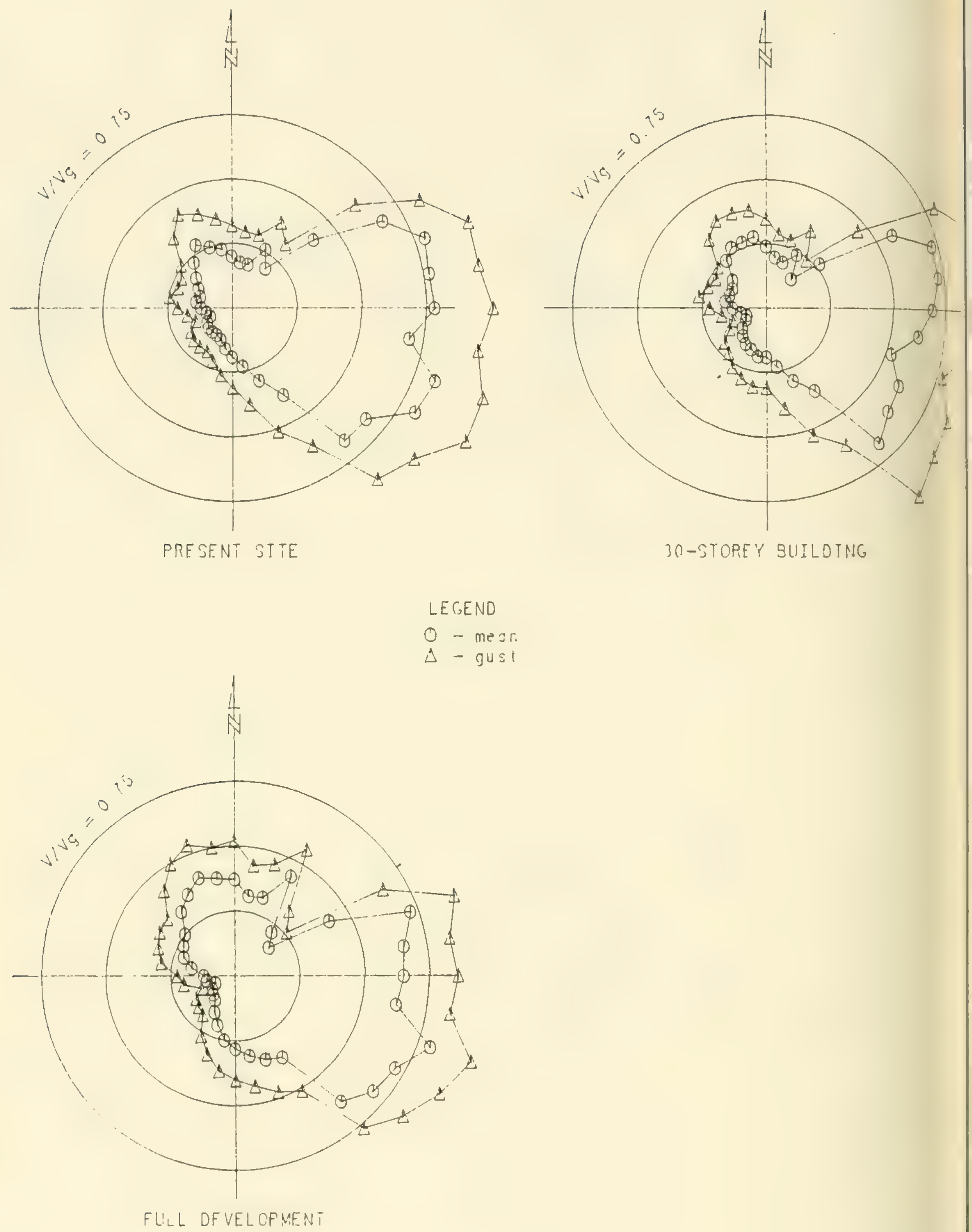


FULL DEVELOPMENT

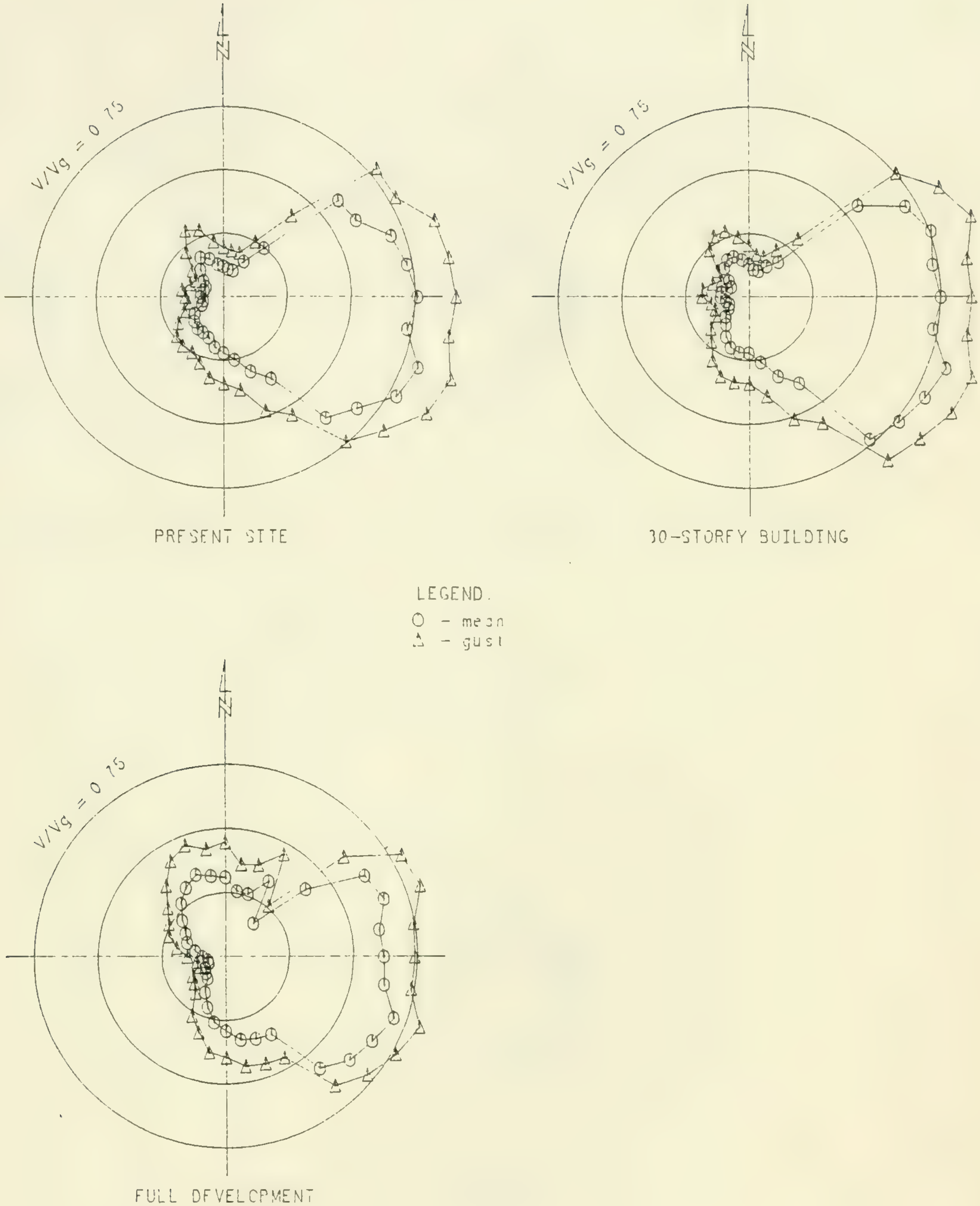
WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 37



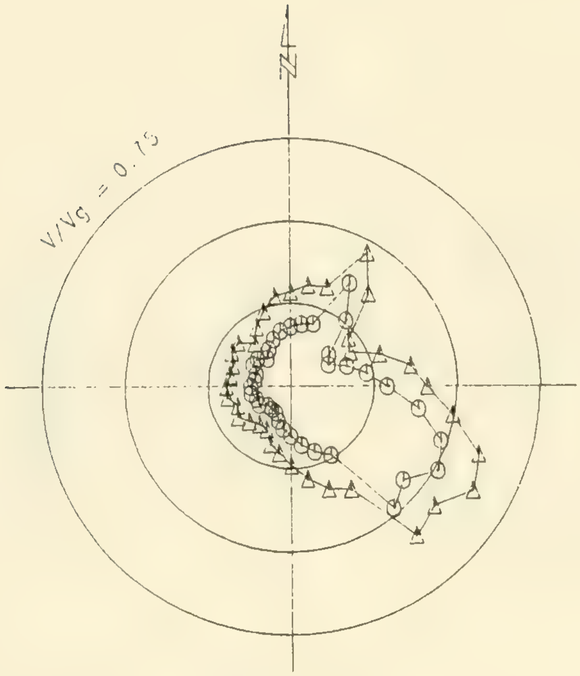
WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 38



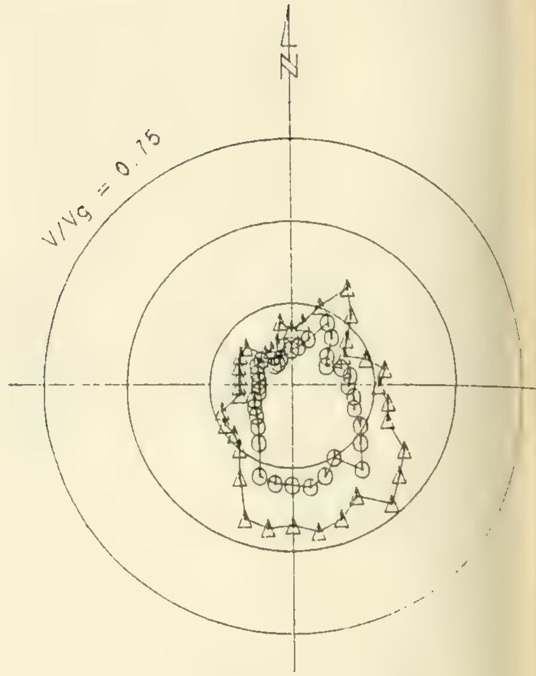
WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 39



WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 40

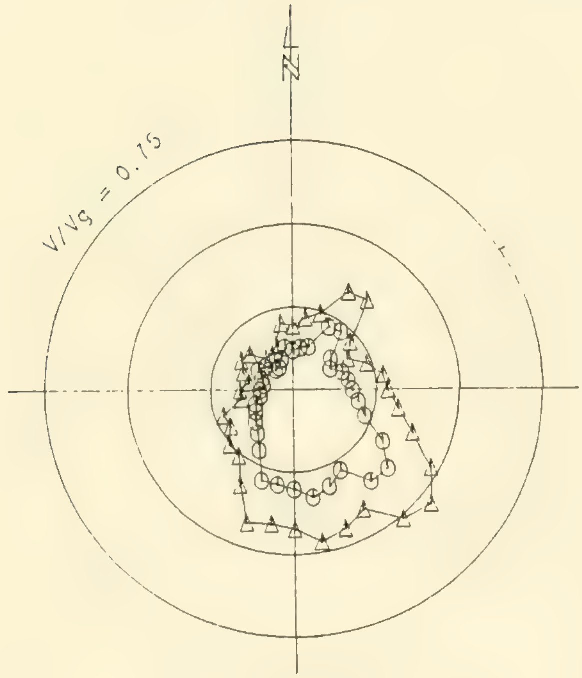


PRESENT SITE



30-STOREY BUILDING

LEGEND.
○ - mean
△ - gust



FULL DEVELOPMENT

WIND SPEEDS AS RATIOS OF THE GRADIENT WIND SPEED
FOR ALL GRADIENT WIND DIRECTIONS
PROBE LOCATION 41

APPENDIX C

AIR QUALITY

C-1 Motor Vehicle Emissions

C-2 CALINE3 Model

C.1 Motor Vehicle Emissions

Motor vehicle emission rates used in this analysis were generated by the EPA MOBILE3 computer program*. Modeling runs were based on the MOBILE3 default national motor vehicle mix (see Table C.1), an average December temperature of 33^{o}F, and the 1985 Massachusetts registration distribution for light duty vehicles, light duty trucks, and heavy duty trucks (see Table C.2). The MOBILE3 default national cold/hot start mix (presented in Table C.3) was used for determining roadway emissions during the peak eight-hour period. A mix with a higher cold start percentage for the rush hour was used to represent the peak one-hour period (see Table C.4). Emission rates are based on peak one-hour and eight-hour travel speeds for vehicles approaching each intersection as estimated from field surveys. Table C.5 presents the 1985 composite free-flow emission rates for the peak one-hour and eight-hour periods. Idle mode emission rates for development of the linear queuing source strength were calculated based on a 5 mph vehicle speed and peak 1- and 8-hour vehicle operating conditions as described above. These are shown in Table C.6. The MOBILE3 idle mode emission rates were not considered as they reflect only hot stabilized conditions. The effect of the statewide inspection/ maintenance (I/M) program was incorporated and included a program implemented in 1983, a 13% stringency level, no mechanic training, an earliest model year of 15 years prior to the analysis year, vehicle type categories of LDGV, LDGT1 and LDGT2, and an idle test with cut points of 1.2% and 220 ppm for CO and HC, respectively. In addition, no alternative I/M credits or anti-tampering program was assumed. The complete MOBILE3 output is found following Table C.5.

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* EPA, User's Guide to MOBILE3: Mobile Source Emissions Model, EPA-460/3-84-002, Ann Arbor, MI, June, 1984.

C.2 CALINE3 Model

For each year and intersection studied the FHWA CALINE3* computer program, adapted for intersection analyses (based on EPA recommended procedures**), was used to predict CO concentrations at sensitive receptor locations. The CALINE3 intersection analysis involved superimposing motor vehicle idling emissions of queue links on free flow links**. Queue lengths utilized in the analysis were developed from worksheet 2 of the EPA Volume 9 Indirect Source Guidelines***. The Volume 9 worksheets are included at the end of this Appendix. The only modification to these procedures was that a queue length of 6 meters instead of eight meters was used.** For overcapacity situations, queue lengths were calculated using the National Cooperative Highway Research Program Report #133 technique as suggested by EPA Region I**. The modeling runs were supplemented by a set of assumptions consistent with DEQE and BRA requirements which include an ambient air temperature of 33°F, and worst meteorological conditions of Pasquill-Gifford Class D stability combined with a 1.0 m/s wind speed for peak 1-hour periods, and 1.3 m/s for peak 8-hour periods. Also, a winter mixing height of 850 meters**** was used. These meteorological data are appropriate for a December day during which peak CO concentrations are expected to occur. For each intersection, the full range of wind directions at 10 degree intervals was examined. In addition, a surface

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* FHWA, CALINE3 - A Versatile Dispersion Model for Predicting Air Pollutant Levels Near Highways and Arterial Streets, FHWA/CA/TL-79/23, November, 1979.

** EPA Region I, Region I Mobile Source Modeling Procedures, January 1, 1985.

*** EPA, Guidelines for Air Quality Maintenance Planning and Analysis Volume 9 (Revised): Evaluating Indirect Sources, Second Printing, EPA-450/4-78-001, Research Triangle Park, NC, September, 1978.

**** Holzworth, G.C., Mixing heights, Wind Speeds, and Potential for Urban Air Quality Throughout the Contiguous United States, USEPA, AP-101, January, 1972.

roughness (Z_0) of 321 cm (defined by CALINE3 for central business districts), and settling and deposition velocities of 0.0 cm/s were incorporated. The CALINE3 model output is large and will therefore be made available for review upon request.

Parking Garage Analysis

A separate analysis was performed to determine impacts of the project's proposed 6 level-850 space underground parking garage. The parking facility analysis predicted maximum 1-hour and 8-hour CO concentrations, for the 1994 build configuration, using the EPA MOBILE3, EPA Indirect Source Guidelines and Halitsky's gas diffusion equations. Concentrations were calculated at all receptor locations, in conjunction with a worst case 1-hour wind speed of 1 m/s and eight-hour speed of 1.3 m/s.

Presently, design of the parking garage and its ventilation system have not been finalized, however, exhaust locations and typical ventilation system design specifications currently under consideration were modeled. Plans are that the proposed underground garage will be serviced by a forced air ventilation unit. The exhaust vents will be located at least ten feet above ground level at the building corner near the Purchase Street/ Pearl Street intersection. A series of four exhaust vents will have a total area of approximately 800 SF with a flow rate totaling about 480,000 cfm.

Emissions were estimated using Worksheet 3 of the EPA Indirect Source Guidelines* These worksheets are included following the intersection analysis worksheet 2's. The ventilation system will emit a total of 8.38 g/s of CO during the peak 1-hour period, and 0.83 g/s of CO during the 8-hour period.

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* EPA, Guidelines for Air Quality Maintenance Planning and Analysis Volume 9 (Revised): Evaluating Indirect Sources, Second Printing, EPA-450/4-78-001, Research Triangle Park, North Carolina, September 1978.

The concentration of CO in the ventilation system exhaust was determined by the following formula:

$$X = 870\ (Q + (X_b)(F))/F$$

where:

X = CO concentration in the ventilation exhaust (ppm)

Q = CO emission rate for the vent system (g/s)

X_b = Background concentration of CO in the makeup air assumed equal to the 1994 background concentrations used in this analysis (g/m^3)

F = Volumetric flow rate (m^3/s)

Background concentrations of 6.0 ppm and 3.6 ppm were used for the 1-hour and 8-hour periods. These levels are equivalent to 6.90 (10^{-3}) and 4.14 (10^{-3}) g/m^3, respectively.
Concentrations of CO in each exhaust vent are predicted to be:

$$X = 38.41 \text{ ppm (1-Hour)}$$
$$= 6.81 \text{ ppm (8-Hour)}$$

For near-field receptors such as those being considered, ambient concentrations were scaled from the ventilation air concentrations using Halitsky's empirical model for gas diffusion near buildings. This model states that the ambient concentration X_a equals:

$$X_a = X/\ulcorner$$

where D is a dilution factor defined as follows:

$$D = 2.22\ M \left[3.16 + \frac{0.1(S)}{(Ae)^{1/2}} \right]^2 \frac{V}{Ve}$$

The terms are defined as follows:

M	=	building configuration factor, equal to 4.0 for ground-level receptors in the cavity of the exhaust plume
S	=	shortest arc distance from source to receptor (m)
Ae	=	area of an exhaust opening, $74.42 m^2$
V	=	ambient wind velocity,
	=	1.0 m/s (1-Hour)
	=	1.3 m/s (8-Hour)
Ve	=	source exit velocity, 3.0 m/s

Tables C.7 and C.8 summarize the model input parameters and results for each receptor examined for the one-hour and eight-hour periods. These values represent actual physical characteristics of the ventilation system as presented above, source-receptor geometry, and worst case wind conditions.

TABLE C.1

NATIONWIDE AVERAGE

MOTOR VEHICLE MIX BY TYPE*

Vehicle Type	Percentage of VMT 1986	Percentage of VMT 1994
Light-Duty Gasoline Vehicles (LDGV)	65.7	62.0
Light-Duty Gasoline Trucks		
0-6000 lb GVW** (LDGT1)	13.0	10.5
Over 6000 lb GVW (LDGT2)	9.0	8.6
Heavy-Duty Gasoline Trucks (HDGV)	3.5	4.1
Light-Duty Diesel Vehicles (LDDV)	2.7	6.4
Light-Duty Diesel Trucks (LDDT)	0.9	3.2
Heavy-Duty Diesel Trucks (HDDT)	4.4	4.6
Motorcycles (MC)	0.7	0.7

* EPA, User's Guide to MOBILE3: Mobile Source Emissions Model, EPA-460/3-84-002, Ann Arbor, MI, June, 1984.

** Gross vehicle weight.

TABLE C.2

1985 MASSACHUSETTS VEHICLE REGISTRATION DISTRIBUTION

Vehicle Age in Years	Percent of Total Vehicles LDGV,LDDV	LDGT,LDDT	HDT (Gas & Diesel)
1	7.07	6.3	4.2
2	10.13	6.9	7.2
3	8.51	5.8	5.4
4	7.74	5.9	5.3
5	7.96	12.6	8.4
6	8.36	9.8	10.0
7	8.40	8.8	8.2
8	7.88	6.5	6.2
9	6.65	4.6	4.8
10	6.00	6.6	6.4
11	6.00	5.7	6.4
12	5.00	4.6	7.8
13	3.00	3.4	3.8
14	2.00	2.7	3.2
15	1.50	2.2	3.0
16	1.10	1.8	2.4
17	0.90	1.7	2.1
18	0.70	1.6	1.9
19	0.60	1.4	1.8
20 +	0.50	1.1	1.5
Total	100.0	100.0	100.0

Source: Massachusetts Department of Environmental Quality Engineering

TABLE C.3

NATIONWIDE AVERAGE

COLD/HOT START MIX FOR MOTOR VEHICLES

Vehicles Cold Start Mode	20.6%
Vehicles Hot Start Mode	27.3%
Vehicles Hot Stabilized Mode	52.1%
Total	100.0%

TABLE C.4

RUSH HOUR COLD/HOT

START MIX FOR MOTOR VEHICLES

Vehicles Cold Start Mode	50.0%
Vehicles Hot Start Mode	10.0%
Vehicles Hot Stabilized Mode	40.0%
Total	100.0%

TABLE C.5

COMPOSITE CO EMISSION RATES

Averaging Period	Roadway	Speed (mph)	CO Emissions Rate (grams/mile) 1986	1994
1-Hour	Purchase & Congress @ Purchase/Congress Intersection and Purchase & Oliver @ Purchase/Oliver Intersection	20	70.2	39.6
	All Others	17	81.3	45.5
8-Hour	Purchase & Oliver Sts.	30	28.3	16.1
	All Others	25	35.5	20.0

TABLE C.6

IDLE MODE EMISSION RATES

Averaging Period	CO Emission Rate (grams/minute 1986	1994
1-Hour	16.25	7.24
8-Hour	10.52	4.67

TABLE C.7

PROPOSED PARKING GARAGE ANALYSIS

INPUTS AND MAXIMUM 1-HOUR IMPACTS*

Intersection	Receptor Number	Receptor Description	S(m)	D	Xa(ppm)
Purchase/Congress	1A	Sidewalk	76.1	48.36	0.79
	2A	Door 1	80.0	49.95	0.78
	3A	Door 2	95.2	53.81	0.71
	4A	Planter	72.4	47.34	0.81
Atlantic/Congress	1B	Bus Station	129.2	64.21	0.60
	2B	IFR Furniture	109.4	58.04	0.66
	3B	IFR Furniture	114.0	59.45	0.65
	4B	Federal Reserve	136.8	66.67	0.58
Atlantic/Surface/ High	1C	Ultimate Deli	270.8	117.5	0.33
	2C	Planter	255.6	111.0	0.35
	3C	Park	343.0	150.7	0.26
	4C	Rowes Wharf-1	319.2	139.3	0.28
	5C	Rowes Wharf-2	350.8	154.6	0.25
Atlantic/Northern	1D	James Hook Lobster	209.2	92.33	0.42
	2D	Coast Guard Bldg.	225.1	98.52	0.39
Purchase/Oliver	1E	125 Doorway	118.0	60.7	0.63
	2E	125 Doorway	116.0	60.1	0.64
	3E	125 Doorway	110.4	58.3	0.66
	4E	Int. Pl. Doorway	133.2	65.5	0.59

* X = 38.41 ppm
V = 1.0 m/s
Ve = 3.0 m/s
Ae = 74.42 m^2
M = 4.0

TABLE C.8

PROPOSED PARKING GARAGE ANALYSIS

INPUTS AND MAXIMUM 8-HOUR IMPACTS*

Intersection	Receptor Number	Receptor Description	S(m)	D	Xa(ppm)
Purchase/Congress	1A	Sidewalk	76.1	62.9	0.11
	2A	Door 1	80.0	64.3	0.11
	3A	Door 2	95.2	70.0	0.10
	4A	Planter	72.4	61.6	0.11
Atlantic/Congress	1B	Bus Station	129.2	83.5	0.08
	2B	IFR Furniture	109.4	75.5	0.09
	3B	IFR Furniture	114.0	77.3	0.09
	4B	Federal Reserve	136.8	86.7	0.08
Atlantic/Surface/ High	1C	Ultimate Deli	270.8	152.8	0.05
	2C	Planter	255.6	144.3	0.05
	3C	Park	343.0	196.1	0.02
	4C	Rowes Wharf-1	319.2	181.2	0.02
	5c	Rowes Wharf-2	350.8	201.1	0.02
Atlantic/Northern	1D	James Hook Lobster	209.2	120.1	0.06
	2D	Coast Guard Bldg.	225.1	128.2	0.05
Purchase/Oliver	1E	125 Doorway	118.0	78.9	0.09
	2E	125 Doorway	116.0	78.1	0.09
	3E	125 Doorway	110.4	75.8	0.09
	4E	Int. Pl. Doorway	133.2	85.2	0.08

* X = 6.81 ppm
V = 1.3 m/s
Ve = 3.0 m/s
Ae = 74.42 m^2
M = 4.0

```
MOBILE3 1986 - INTERSECTION ANALYSIS

I/M PROGRAM SELECTED:

    START YEAR (JANUARY 1):            1983
    PRE-1981 MYR STRINGENCY RATE:      13%
    MECHANIC TRAINING PROGRAM?:        NO
    FIRST MODEL YEAR COVERED:          1971
    LAST MODEL YEAR COVERED:           1986
    VEHICLE TYPES COVERED:             LDGV, LDGT1, LDGT2
    1981 & LATER MYR TEST TYPE:        IDLE
    1981 & LATER MYR TEST CUTPOINTS: 1.2% ICO / 220 PPM IHC

TOTAL HC EMISSION FACTORS INCLUDE EVAPORATIVE HC EMISSION FACTORS.

------------------------------------------------------------------------------

USER SUPPLIED VEH REGISTRATION DISTRIBUTIONS.

CAL. YEAR: 1986          REGION: LOW             ALTITUDE:  500. FT.
                    I/M PROGRAM: YES         AMBIENT TEMP:   33.0 (F)
               ANTI-TAM. PROGRAM: NO       OPERATING MODE:   50.0 / 10.0 / 50.0

VEH. TYPE:  LDGV  LDGT1  LDGT2   LDGT   HDGV   LDDV   LDDT   HDDV    MC   ALL VEH
            ------ ------ ------ ------ ------ ------ ------ ------ ------ ------
VEH. SPD.:  5.0    5.0    5.0           5.0    5.0    5.0    5.0    5.0
  VMT MIX:  0.657  0.130  0.090         0.035  0.027  0.009  0.044  0.007

COMPOSITE EMISSION FACTORS (GM/MILE)
EXHST  CO: 168.10 278.14 313.04 292.43 481.71   3.98   4.73  37.13 212.04 195.03
------------------------------------------------------------------------------

USER SUPPLIED VEH REGISTRATION DISTRIBUTIONS.

CAL. YEAR: 1986          REGION: LOW             ALTITUDE:  500. FT.
                    I/M PROGRAM: YES         AMBIENT TEMP:   33.0 (F)
               ANTI-TAM. PROGRAM: NO       OPERATING MODE:   50.0 / 10.0 / 50.0

VEH. TYPE:  LDGV  LDGT1  LDGT2   LDGT   HDGV   LDDV   LDDT   HDDV    MC   ALL VEH
            ------ ------ ------ ------ ------ ------ ------ ------ ------ ------
VEH. SPD.:  17.0   17.0   17.0          17.0   17.0   17.0   17.0   17.0
  VMT MIX:  0.657  0.130  0.090         0.035  0.027  0.009  0.044  0.007

COMPOSITE EMISSION FACTORS (GM/MILE)
EXHST  CO:  72.86 113.82 115.71 114.59 198.69   1.76   2.09  16.42  58.36  81.27
------------------------------------------------------------------------------

USER SUPPLIED VEH REGISTRATION DISTRIBUTIONS.

CAL. YEAR: 1986          REGION: LOW             ALTITUDE:  500. FT.
                    I/M PROGRAM: YES         AMBIENT TEMP:   33.0 (F)
               ANTI-TAM. PROGRAM: NO       OPERATING MODE:   50.0 / 10.0 / 50.0

VEH. TYPE:  LDGV  LDGT1  LDGT2   LDGT   HDGV   LDDV   LDDT   HDDV    MC   ALL VEH
            ------ ------ ------ ------ ------ ------ ------ ------ ------ ------
VEH. SPD.:  20.0   20.0   20.0          20.0   20.0   20.0   20.0   20.0
  VMT MIX:  0.657  0.130  0.090         0.035  0.027  0.009  0.044  0.007

COMPOSITE EMISSION FACTORS (GM/MILE)
EXHST  CO:  63.43  98.15  98.21  98.18 167.31   1.49   1.78  13.95  49.74  70.19
------------------------------------------------------------------------------
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USER SUPPLIED VEH REGISTRATION DISTRIBUTIONS.

CAL. YEAR: 1986          REGION: LOW             ALTITUDE:  500. FT.
                    I/M PROGRAM: YES         AMBIENT TEMP:   33.0 (F)
               ANTI-TAM. PROGRAM: NO       OPERATING MODE:   20.6 / 27.3 / 20.6

VEH. TYPE:  LDGV  LDGT1  LDGT2   LDGT   HDGV   LDDV   LDDT   HDDV    MC   ALL VEH
            ------ ------ ------ ------ ------ ------ ------ ------ ------ ------
VEH. SPD.:  5.0    5.0    5.0           5.0    5.0    5.0    5.0    5.0
  VMT MIX:  0.657  0.130  0.090         0.035  0.027  0.009  0.044  0.007

COMPOSITE EMISSION FACTORS (GM/MILE)
EXHST  CO: 101.59 170.40 196.70 181.16 481.71   3.46   4.15  37.13 130.78 126.24
------------------------------------------------------------------------------

USER SUPPLIED VEH REGISTRATION DISTRIBUTIONS.

CAL. YEAR: 1986          REGION: LOW             ALTITUDE:  500. FT.
                    I/M PROGRAM: YES         AMBIENT TEMP:   33.0 (F)
               ANTI-TAM. PROGRAM: NO       OPERATING MODE:   20.6 / 27.3 / 20.6

VEH. TYPE:  LDGV  LDGT1  LDGT2   LDGT   HDGV   LDDV   LDDT   HDDV    MC   ALL VEH
            ------ ------ ------ ------ ------ ------ ------ ------ ------ ------
VEH. SPD.:  25.0   25.0   25.0          25.0   25.0   25.0   25.0   25.0
  VMT MIX:  0.657  0.130  0.090         0.035  0.027  0.009  0.044  0.007

COMPOSITE EMISSION FACTORS (GM/MILE)
EXHST  CO:  30.16  46.98  47.15  47.05 131.28   1.03   1.23  11.03  24.50  35.48
------------------------------------------------------------------------------

USER SUPPLIED VEH REGISTRATION DISTRIBUTIONS.

CAL. YEAR: 1986          REGION: LOW             ALTITUDE:  500. FT.
                    I/M PROGRAM: YES         AMBIENT TEMP:   33.0 (F)
               ANTI-TAM. PROGRAM: NO       OPERATING MODE:   20.6 / 27.3 / 20.6

VEH. TYPE:  LDGV  LDGT1  LDGT2   LDGT   HDGV   LDDV   LDDT   HDDV    MC   ALL VEH
            ------ ------ ------ ------ ------ ------ ------ ------ ------ ------
VEH. SPD.:  30.0   30.0   30.0          30.0   30.0   30.0   30.0   30.0
  VMT MIX:  0.657  0.130  0.090         0.035  0.027  0.009  0.044  0.007

COMPOSITE EMISSION FACTORS (GM/MILE)
EXHST  CO:  24.05  36.94  36.99  36.96 108.84   0.85   1.02   9.12  20.03  28.34
------------------------------------------------------------------------------
```

```
MOBILE3 1994 - INTERSECTION ANALYSIS

I/M PROGRAM SELECTED:

    START YEAR (JANUARY 1):               1983
    PRE-1981 MYR STRINGENCY RATE:         13%
    MECHANIC TRAINING PROGRAM?:           NO
    FIRST MODEL YEAR COVERED:             1979
    LAST MODEL YEAR COVERED:              1994
    VEHICLE TYPES COVERED:                LDGV, LDGT1, LDGT2
    1981 & LATER MYR TEST TYPE:           IDLE
    1981 & LATER MYR TEST CUTPOINTS:      1.2% ICO / 220 PPM IHC

TOTAL HC EMISSION FACTORS INCLUDE EVAPORATIVE HC EMISSION FACTORS.

-----------------------------------------------------------------------------------

CAL. YEAR: 1994          REGION: LOW           ALTITUDE:  500. FT.
                    I/M PROGRAM: YES       AMBIENT TEMP:   33.0 (F)
               ANTI-TAM. PROGRAM: NO      OPERATING MODE:  50.0 / 10.0 / 50.0

VEH. TYPE:  LDGV   LDGT1  LDGT2   LDGT   HDGV   LDDV   LDDT   HDDV   MC    ALL VEH
            ------ ------ ------ ------ ------ ------ ------ ------ ------ ------
VEH. SPD.:  5.0    5.0    5.0           5.0    5.0    5.0    5.0    5.0
 VMT MIX:   0.620  0.105  0.086         0.041  0.064  0.032  0.046  0.007

COMPOSITE EMISSION FACTORS (GM/MILE)
EXHST  CO: 82.79 134.18 146.62 139.77 142.01   4.03   4.62  27.46 210.52  86.90
-----------------------------------------------------------------------------------

CAL. YEAR: 1994          REGION: LOW           ALTITUDE:  500. FT.
                    I/M PROGRAM: YES       AMBIENT TEMP:   33.0 (F)
               ANTI-TAM. PROGRAM: NO      OPERATING MODE:  50.0 / 10.0 / 50.0

VEH. TYPE:  LDGV   LDGT1  LDGT2   LDGT   HDGV   LDDV   LDDT   HDDV   MC    ALL VEH
            ------ ------ ------ ------ ------ ------ ------ ------ ------ ------
VEH. SPD.:  17.0   17.0   17.0          17.0   17.0   17.0   17.0   17.0
 VMT MIX:   0.620  0.105  0.086         0.041  0.064  0.032  0.046  0.007

COMPOSITE EMISSION FACTORS (GM/MILE)
EXHST  CO: 46.81  67.72  68.04  67.86  58.57   1.78   2.04  12.15  57.94  45.48
-----------------------------------------------------------------------------------

CAL. YEAR: 1994          REGION: LOW           ALTITUDE:  500. FT.
                    I/M PROGRAM: YES       AMBIENT TEMP:   33.0 (F)
               ANTI-TAM. PROGRAM: NO      OPERATING MODE:  50.0 / 10.0 / 50.0

VEH. TYPE:  LDGV   LDGT1  LDGT2   LDGT   HDGV   LDDV   LDDT   HDDV   MC    ALL VEH
            ------ ------ ------ ------ ------ ------ ------ ------ ------ ------
VEH. SPD.:  20.0   20.0   20.0          20.0   20.0   20.0   20.0   20.0
 VMT MIX:   0.620  0.105  0.086         0.041  0.064  0.032  0.046  0.007

COMPOSITE EMISSION FACTORS (GM/MILE)
EXHST  CO: 40.99  59.01  58.70  58.87  49.32   1.52   1.74  10.32  49.37  39.61
-----------------------------------------------------------------------------------

CAL. YEAR: 1994          REGION: LOW           ALTITUDE:  500. FT.
                    I/M PROGRAM: YES       AMBIENT TEMP:   33.0 (F)
               ANTI-TAM. PROGRAM: NO      OPERATING MODE:  20.6 / 27.3 / 20.6

VEH. TYPE:  LDGV   LDGT1  LDGT2   LDGT   HDGV   LDDV   LDDT   HDDV   MC    ALL VEH
            ------ ------ ------ ------ ------ ------ ------ ------ ------ ------
VEH. SPD.:  5.0    5.0    5.0           5.0    5.0    5.0    5.0    5.0
 VMT MIX:   0.620  0.105  0.086         0.041  0.064  0.032  0.046  0.007

COMPOSITE EMISSION FACTORS (GM/MILE)
EXHST  CO: 49.84  84.00  93.80  88.41 142.01   3.49   4.05  27.46 129.71  56.06
-----------------------------------------------------------------------------------

CAL. YEAR: 1994          REGION: LOW           ALTITUDE:  500. FT.
                    I/M PROGRAM: YES       AMBIENT TEMP:   33.0 (F)
               ANTI-TAM. PROGRAM: NO      OPERATING MODE:  20.6 / 27.3 / 20.6

VEH. TYPE:  LDGV   LDGT1  LDGT2   LDGT   HDGV   LDDV   LDDT   HDDV   MC    ALL VEH
            ------ ------ ------ ------ ------ ------ ------ ------ ------ ------
VEH. SPD.:  25.0   25.0   25.0          25.0   25.0   25.0   25.0   25.0
 VMT MIX:   0.620  0.105  0.086         0.041  0.064  0.032  0.046  0.007

COMPOSITE EMISSION FACTORS (GM/MILE)
EXHST  CO: 19.72  29.34  29.26  29.30  38.70   1.04   1.20   8.16  24.26  20.03
-----------------------------------------------------------------------------------

CAL. YEAR: 1994          REGION: LOW           ALTITUDE:  500. FT.
                    I/M PROGRAM: YES       AMBIENT TEMP:   33.0 (F)
               ANTI-TAM. PROGRAM: NO      OPERATING MODE:  20.6 / 27.3 / 20.6

VEH. TYPE:  LDGV   LDGT1  LDGT2   LDGT   HDGV   LDDV   LDDT   HDDV   MC    ALL VEH
            ------ ------ ------ ------ ------ ------ ------ ------ ------ ------
VEH. SPD.:  30.0   30.0   30.0          30.0   30.0   30.0   30.0   30.0
 VMT MIX:   0.620  0.105  0.086         0.041  0.064  0.032  0.046  0.007

COMPOSITE EMISSION FACTORS (GM/MILE)
EXHST  CO: 15.79  23.26  23.15  23.21  32.08   0.86   0.99   6.75  19.80  16.05
-----------------------------------------------------------------------------------
```

```
MOBILE3 1994 - GARAGE ANALYSIS
I/M PROGRAM SELECTED:

    START YEAR (JANUARY 1):            1983
    PRE-1981 MYR STRINGENCY RATE:      13%
    MECHANIC TRAINING PROGRAM?:        NO
    FIRST MODEL YEAR COVERED:          1979
    LAST MODEL YEAR COVERED:           1994
    VEHICLE TYPES COVERED:             LDGV, LDGT1, LDGT2
    1981 & LATER MYR TEST TYPE:        IDLE
    1981 & LATER MYR TEST CUTPOINTS:   1 2% ICO / 220 PPM IHC

TOTAL HC EMISSION FACTORS INCLUDE EVAPORATIVE HC EMISSION FACTORS.

---------------------------------------------------------------------------------

CAL. YEAR: 1994           REGION: LOW           ALTITUDE:  500  FT.
                     I/M PROGRAM: YES       AMBIENT TEMP:   33.0 (F)
               ANTI-TAM. PROGRAM: NO      OPERATING MODE:  100 0 /   0.0 /100.0

VEH. TYPE:  LDGV  LDGT1  LDGT2   LDGT   HDGV   LDDV   LDDT   HDDV    MC   ALL VEH
            ----- -----  -----  -----  -----  -----  -----  -----  -----  -----
VEH. SPD.:  15.0   15.0   15.0          15.0   15.0   15.0   15.0   15.0
  VMT MIX:  0.620  0.105  0.086         0.041  0.064  0.032  0.046  0.007

COMPOSITE EMISSION FACTORS (GM/MILE)
EXHST  CO:103.11 146.12 146.90 146.47  66.41   2.86   3.28  13.66 127.67  96.34
---------------------------------------------------------------------------------

CAL. YEAR: 1994           REGION: LOW           ALTITUDE:  500. FT.
                     I/M PROGRAM: YES       AMBIENT TEMP:   33.0 (F)
               ANTI-TAM. PROGRAM: NO      OPERATING MODE:   50.0 /   0.0 / 50.0

VEH. TYPE:  LDGV  LDGT1  LDGT2   LDGT   HDGV   LDDV   LDDT   HDDV    MC   ALL VEH
            ----- -----  -----  -----  -----  -----  -----  -----  -----  -----
VEH. SPD.:  15.0   15.0   15.0          15.0   15.0   15.0   15.0   15.0
  VMT MIX:  0.620  0.105  0.086         0.041  0.064  0.032  0.046  0.067

COMPOSITE EMISSION FACTORS (GM/MILE)
EXHST  CO: 49.59  72.33  73.33  72.78  66 41   1.91   2.17  13.66  64.02  48.58
---------------------------------------------------------------------------------
```

WORKSHEET 1 - TRAFFIC INFORMATION

Intersection Purchase / Congress

Case # 1 Year 1986

1.	Road segment or intersection approach identification	PS*	CE*
2.	Observed 1-hr volume (vph)	1344	1167
	Observed 8-hr volume (vph)	941	792
	Projected 1-hr peak demand (vph)		
	Projected 8-hr peak demand (vph)		
3.	Percentage cold starts ([illegible])	50.0/20.6	
4.	Percentage trucks and buses	11.7	
5.	Metropolitan population		
6.	Slope		
7.	Free-flow parameters		
	Number of lanes	4	2
	Average lane width (ft)	15	15
	Design speed (mph) ([illegible])	20/25	20/25
	Highway type (see Figures 2-5)	Urban [illegible]	
8.	Intersection parameters		
	Intersection designation		
	Approach width (ft)	60	60
	Percentage right turns	0	9
	Percentage left turns	49	0
	Type control and description of signal controller	Signalized	
9.	Area source parameters		
	Parking lot gate designation		
	Projected 1-hr peak entrance demand (vph)		
	Projected 1-hr peak exit demand (vph)		
	Projected 8-hr peak entrance demand (vph)		
	Projected 8-hr peak exit demand (vph)		
	Parking lot area (m^2)		
	Parking lot capacity (veh)		
	Running time required to access auxiliary parking (s)		
	Facility emptying time		
	Average cars per stall		
	Average area per stall (m^2)		

* PS : Purchase Street SB

CE : Congress Street EB

WORKSHEET 1 - TRAFFIC INFORMATION

Intersection Purchase / [illegible]

Case # 2 Year [illegible]

		PS*	CE†
1.	Road segment or intersection approach identification	PS*	CE†
2.	Observed 1-hr volume (vph)		
	Observed 8-hr volume (vph)		
	Projected 1-hr peak demand (vph)	1874	2458
	Projected 8-hr peak demand (vph)	1312	1671
3.	Percentage cold starts ([illegible])	50.0	[illegible] 6
4.	Percentage trucks and buses	11.7	
5.	Metropolitan population		
6.	Slope		
7.	Free-flow parameters		
	Number of lanes	[illegible]	4
	Average lane width (ft)	15	15
	Design speed (mph) ([illegible])	20/25	20/25
	Highway type (see Figures 2-5)	Urban [illegible]	
8.	Intersection parameters		
	Intersection designation		
	Approach width (ft)	60	60
	Percentage right turns	6	4
	Percentage left turns	12	0
	Type control and description of signal controller	[illegible]	
9.	Area source parameters		
	Parking lot gate designation		
	Projected 1-hr peak entrance demand (vph)		
	Projected 1-hr peak exit demand (vph)		
	Projected 8-hr peak entrance demand (vph)		
	Projected 8-hr peak exit demand (vph)		
	Parking lot area (m^2)		
	Parking lot capacity (veh)		
	Running time required to access auxiliary parking (s)		
	Facility emptying time		
	Average cars per stall		
	Average area per stall (m^2)		

*† PS = Purchase St. SB

CE = [illegible] EB

WORKSHEET 1 - TRAFFIC INFORMATION

Intersection: Purchase / Congress

Case # 3 Year [illegible]

		PS*	CE+
1.	Road segment or intersection approach identification	PS*	CE+
2.	Observed 1-hr volume (vph)		
	Observed 8-hr volume (vph)		
	Projected 1-hr peak demand (vph)	2440	2458
	Projected 8-hr peak demand (vph)	1708	1671
3.	Percentage cold starts (1 hr/8 hr)	50.0/20.6	
4.	Percentage trucks and buses	11.7	
5.	Metropolitan population		
6.	Slope		
7.	Free-flow parameters		
	Number of lanes	4	4
	Average lane width (ft)	15	15
	Design speed (mph) (1 hr/8 hr)	20/25	20/25
	Highway type (see Figures 2-5)	Urban arterial	
8.	Intersection parameters		
	Intersection designation		
	Approach width (ft)	60	60
	Percentage right turns	0	4
	Percentage left turns	40	0
	Type control and description of signal controller	Signalized	
9.	Area source parameters		
	Parking lot gate designation		
	Projected 1-hr peak entrance demand (vph)		
	Projected 1-hr peak exit demand (vph)		
	Projected 8-hr peak entrance demand (vph)		
	Projected 8-hr peak exit demand (vph)		
	Parking lot area (m^2)		
	Parking lot capacity (veh)		
	Running time required to access auxiliary parking (s)		
	Facility emptying time		
	Average cars per stall		
	Average area per stall (m^2)		

* PS : Purchase St SB

\+ CE : Congress St EB

WORKSHEET B - CAPACITY ANALYSIS

Intersection Purchase / Congress

Case # 1 Year 1986

Step	Symbol	Input/Units					
1	i	Road segment (or approach) designation	PSL	PSS	CE		
2		Free flow capacity computation:					
2.1	M_i	Number of lanes					
2.2	W_f	Adjustment for lane width (Table B-1)					
2.3	T_i	Adjustment for trucks (Table B-2)					
2.4	C_i	Free flow capacity					
3		Signalized intersection capacity:					
3.1	j	Green signal phase identification	ΦD*	ΦB	ΦC		
3.2	Wa_i	Approach width with parking (ft)	41	35	68		
3.3		Percent right turners	0	0	9		
3.4		Percent left turners	0	0	0		
3.5		Metropolitan area size	2.5M				
3.6	$Cs_{i,j}$	Capacity service volume (vph or green)	4200	3750	7000		8-Hr
4		Signalized intersection green phase and cycle length:	2940	2625	4900		1-Hr **
4.1	$V_{i,j}$	Demand Volume for approach and phase					
4.2	$V_{i,j}/Cs_{i,j})$	Volume to green capacity ratio					
4.3	approx G/Cy	Approximate G/Cy					
4.4	$\sum_j \max(V_{i,j}Cs_{i,j})$	Sum of the maximum V/C ratios for each signal phase					
4.5	Cy	Signal cycle time (sec)					
4.6	Gj	Green phase length					
4.7	Gj/Cy	Green phase to cycle time ratio					
4.8	$C_{i,j}$	Capacity for approach i phase j					
5		Two-way stop, two-way yield or uncontrolled intersection:					
5.1	V_m+V_n	Major street two-way volume					
5.2	C_i	Cross street capacity					
6		Four-way stop intersections:					
6.1	V_i	Approach volume					
6.2	Spi	Demand split on cross streets					
6.3	C_i	Capacity of approach					
7	C_i	Approach capacity $\sum_j C_{i,j}$ 5.2 for a four-way stop or 6.3 for a two-way stop					

* ΦD = ΦA + ΦB = 16 + 36 = 52 sec.

* Capacity reduced by 30% during peak 1-hour to account for pedestrian activity

WORKSHEET B - CAPACITY ANALYSIS

Intersection Purchase / Congress

Case # 293 Year 1994

Step	Symbol	Input/Units				
1	i	Road segment (or approach) designation	PSL	PSS	CE	
2		Free flow capacity computation:				
2.1	M_i	Number of lanes				
2.2	W_f	Adjustment for lane width (Table B-1)				
2.3	T_i	Adjustment for trucks (Table B-2)				
2.4	C_i	Free flow capacity				
3		Signalized intersection capacity:				
3.1	j	Green signal phase identification	ØD	ØB	ØC	
3.2	Wa_i	Approach width with parking (ft)	29	47	68	
3.3		Percent right turners	0	0	4	
3.4		Percent left turners	0	0	0	
3.5		Metropolitan area size	2.5M			
3.6	$Cs_{i,j}$	Capacity service volume (vph or green)	~~3000~~ 2100	~~4800~~ 3360	~~7000~~ 4900	
4		Signalized intersection green phase and cycle length:				
4.1	$V_{i,j}$	Demand Volume for approach and phase				
4.2	$V_{i,j}/Cs_{i,j})$	Volume to green capacity ratio				
4.3	approx G/Cy	Approximate G/Cy				
4.4	$\Sigma_j \max(V_{i,j}Cs_{i,j})$	Sum of the maximum V/C ratios for each signal phase				
4.5	Cy	Signal cycle time (sec)				
4.6	Gj	Green phase length				
4.7	Gj/Cy	Green phase to cycle time ratio				
4.8	$C_{i,j}$	Capacity for approach i phase j				
5		Two-way stop, two-way yield or uncontrolled intersection:				
5.1	V_m+V_n	Major street two-way volume				
5.2	C_i	Cross street capacity				
6		Four-way stop intersections:				
6.1	V_i	Approach volume				
6.2	Spi	Demand split on cross streets				
6.3	C_i	Capacity of approach				
7	C_i	Approach capacity $\Sigma_j C_{i,j}$ 5.2 for a four-way stop or 6.3 for a two-way stop				

2Hr → (3000, 4800, 7000)
1Hr (2100, 3360, 4900)

WORKSHEET B - CAPACITY ANALYSIS

Intersection: Purchase / Congress

Case # A.1 - 8 Hr Year 1986 1994

Step	Symbol	Input/Units				
1	i	Road segment (or approach) designation	PSL	PSS	CE	
2		Free flow capacity computation:				
2.1	M_i	Number of lanes	1	2	4	
2.2	W_F	Adjustment for lane width (Table B-1)				
2.3	T_i	Adjustment for trucks (Table B-2)				
2.4	C_i	Free flow capacity				
3		Signalized intersection capacity:				
3.1	j	Green signal phase identification				
3.2	Wa_i	Approach width with parking (ft)	31	40	68	
3.3		Percent right turners	0	0	9	
3.4		Percent left turners	0	0	0	
3.5		Metropolitan area size	2.5M			
3.6	$Cs_{i,j}$	Capacity service volume (vph or green)	3400	4100	7000	
4		Signalized intersection green phase and cycle length:				
4.1	$V_{i,j}$	Demand Volume for approach and phase				
4.2	$V_{i,j}/Cs_{i,j})$	Volume to green capacity ratio				
4.3	approx G/Cy	Approximate G/Cy				
4.4	$\sum_j \max(V_{i,j}Cs_{i,j})$	Sum of the maximum V/C ratios for each signal phase				
4.5	Cy	Signal cycle time (sec)				
4.6	Gj	Green phase length				
4.7	Gj/Cy	Green phase to cycle time ratio				
4.8	$C_{i,j}$	Capacity for approach i phase j				
5		Two-way stop, two-way yield or uncontrolled intersection:				
5.1	V_m+V_n	Major street two-way volume				
5.2	C_i	Cross street capacity				
6		Four-way stop intersections:				
6.1	V_i	Approach volume				
6.2	Spi	Demand split on cross streets				
6.3	C_i	Capacity of approach				
7	C_i	Approach capacity $\sum_j C_{i,j}$ 5.2 for a four-way stop or 6.3 for a two-way stop				

8 hr.

WORKSHEET 2 - LINE SOURCE EMISSION RATE COMPUTATION

Intersection Purchase / Congress

Case # 1 Year 1986 Averaging Time 1 Hour

Step	Symbol	Input/Units	Traffic Stream			
1	i	Road segment (or approach identification)	PSL	PSS	CE	
2	V_i	Demand volume (vph)	664	680	1164	
3	C_i	Free-flow capacity (vph)				
4	S_i	Cruise speed (mph)	20	20	20	
5	Ef_i	Free-flow emissions (g/veh-m)				
6.1	M_i	Number of lanes in approach i	2	2	4	
6.2	j	Signalized intersections phase identification	ØD	ØB	ØC	
6.3	$Cs_{i,j}$	Capacity service volume of approach i for phase j (vph of green)	2940	2625	4900	
6.4	$V_{i,j}$	Demand volume for approach i, phase j (vph)	664	680	1164	
6.5	C_y	Signal cycle length (s)	90			
6.6	$G_{i,j}$	Green phase length for approach i, phase j (s)	52	36	38	
6.7	C_i	Capacity of approach i·(vph))	1699	1050	2069	
6.8	$P_{i,j}$	Proportion of vehicles that stop	0.55	0.81	0.76	
6.9	$N_{i,j}$	Number of vehicles that stop per signal cycle	9.05	13.8	22.1	
7	N_i	Average number of vehicles in queue at four way stop or two-way stop or end of green phase	0.64	1.84	1.29	
8	Lq_i	Length of vehicle queue for approach i (veh-m/lane)	29.1	46.8	35.0	
9	Rq_i	Average excess running time on approach (s/veh)				
10	Ea_i	emissions from acceleration (g/veh-m)				
11	Ed_i	emissions from deceleration (g/veh-m)				
12	Qad_i	emission rate from acceleration and deceleration (g/m-s)				
13	Lad_i	Length of acceleration and deceleration (m)				
14	Le_i	Length over which excess emissions apply (m)				
15	Fs_i	Average idling emission rate (g/s)				
16	Qe	Average emission rate (g/m-s)				
17	Qe_i	Adjusted excess emission rate (g/s-m)				
18	Qfc_i	Free-flow emission rate (g/s-m)				

WORKSHEET 2 - LINE SOURCE EMISSION RATE COMPUTATION

Intersection Purchase / [illegible]

Case # 2 Year 1994 Averaging Time 1 Hour

Step	Symbol	Input/Units	Traffic Stream			
1	i	Road segment (or approach identification)	PSL	PSS	CE	
2	V_i	Demand volume (vph)	790	1084	2458	
3	C_i	Free-flow capacity (vph)				
4	S_i	Cruise speed (mph)	20	20	20	
5	Ef_i	Free-flow emissions (g/veh-m)				
6.1	M_i	Number of lanes in approach i	1	3	4	
6.2	j	Signalized intersections phase identification	ØD	ØB	ØC	
6.3	$Cs_{i,j}$	Capacity service volume of approach i for phase j (vph of green)	2100	3360	4900	
6.4	$V_{i,j}$	Demand volume for approach i, phase j (vph)	790	1084	2458	
6.5	C_y	Signal cycle length (s)	90			
6.6	$G_{i,j}$	Green phase length for approach i, phase j (s)	52	36	38	
6.7	C_i	Capacity of approach i·(vph))	1213	1344	2069	
6.8	$P_{i,j}$	Proportion of vehicles that stop	0.68	0.89		
6.9	$N_{i,j}$	Number of vehicles that stop per signal cycle	13.4	24.0		
7	N_i	Average number of vehicles in queue at four way stop or two-way stop or end of green phase	1,9	4,2		
8	Lq_i	Length of vehicle queue for approach i (veh-m/lane)	91.4	56.4	292	
9	Rq_i	Average excess running time on approach (s/veh)				
10	Ea_i	emissions from acceleration (g/veh-m)				
11	Ed_i	emissions from deceleration (g/veh-m)				
12	Qad_i	emission rate from acceleration and deceleration (g/m-s)				
13	Lad_i	Length of acceleration and deceleration (m)				
14	Le_i	Length over which excess emissions apply (m)				
15	Fs_i	Average idling emission rate (g/s)				
16	Qe	Average emission rate (g/m-s)				
17	Qe_i	Adjusted excess emission rate (g/s-m)				
18	Qfc_i	Free-flow emission rate (g/s-m)				

[illegible] 292

WORKSHEET 2 - LINE SOURCE EMISSION RATE COMPUTATION

Intersection Purchase / Congress

Case # 2 Year 1994 Averaging Time 8 Hour

Step	Symbol	Input/Units	Traffic Stream			
1	i	Road segment (or approach identification)	PSL	PSS	CE	
2	V_i	Demand volume (vph)	553	759	1671	
3	C_i	Free-flow capacity (vph)				
4	S_i	Cruise speed (mph)	25	25	25	
5	Ef_i	Free-flow emissions (g/veh-m)				
6.1	M_i	Number of lanes in approach i	1	2	4	
6.2	j	Signalized intersections phase identification	ØD	ØB	ØC	
6.3	$Cs_{i,j}$	Capacity service volume of approach i for phase j (vph of green)	3400	4100	7000	
6.4	$V_{i,j}$	Demand volume for approach i, phase j (vph)	553	759	1671	
6.5	C_y	Signal cycle length (s)	90			
6.6	$G_{i,j}$	Green phase length for approach i, phase j (s)	52	36	38	
6.7	C_i	Capacity of approach i (vph))	1964	1640	2956	
6.8	$P_{i,j}$	Proportion of vehicles that stop	0.50	0.74	0.76	
6.9	$N_{i,j}$	Number of vehicles that stop per signal cycle	7.0	14.0	31.7	
7	N_i	Average number of vehicles in queue at four way stop or two-way stop or end of green phase	0.39	0.86	1.3	
8	Lq_i	Length of vehicle queue for approach i (veh-m/lane)	44.2	44.5	47.5	
9	Rq_i	Average excess running time on approach (s/veh)				
10	Ea_i	emissions from acceleration (g/veh-m)				
11	Ed_i	emissions from deceleration (g/veh-m)				
12	Qad_i	emission rate from acceleration and deceleration (g/m-s)				
13	Lad_i	Length of acceleration and deceleration (m)				
14	Le_i	Length over which excess emissions apply (m)				
15	Fs_i	Average idling emission rate (g/s)				
16	Qe	Average emission rate (g/m-s)				
17	Qe_i	Adjusted excess emission rate (g/s-m)				
18	Qfc_i	Free-flow emission rate (g/s-m)				

WORKSHEET 2 - LINE SOURCE EMISSION RATE COMPUTATION

Intersection Purchase / Congress

Case # 3 Year 1994 Averaging Time 1 Hour

Step	Symbol	Input/Units	Traffic Stream			
1	i	Road segment (or approach identification)	PSL	PSS	CE	
2	V_i	Demand volume (vph)	964	1476	2458	
3	C_i	Free-flow capacity (vph)				
4	S_i	Cruise speed (mph)	20	20	20	
5	Ef_i	Free-flow emissions (g/veh-m)				
6.1	M_i	Number of lanes in approach i	1	3	4	
6.2	j	Signalized intersections phase identification	ØD	ØB	ØC	
6.3	$Cs_{i,j}$	Capacity service volume of approach i for phase j (vph of green)	2100	3360	4900	
6.4	$V_{i,j}$	Demand volume for approach i, phase j (vph)	964	1476	2458	
6.5	C_y	Signal cycle length (s)	70			
6.6	$G_{i,j}$	Green phase length for approach i, phase j (s)	52	36 *	38 *	
6.7	C_i	Capacity of approach i·(vph))	1213	[illegible] *	2069 *	
6.8	$P_{i,j}$	Proportion of vehicles that stop	0.79			
6.9	$N_{i,j}$	Number of vehicles that stop per signal cycle	18.8			
7	N_i	Average number of vehicles in queue at four way stop or two-way stop or end of green phase	3.9	[illegible]		
8	Lq_i	Length of vehicle queue for approach i (veh-m/lane)	136	396	292.	
9	Rq_i	Average excess running time on approach (s/veh)				
10	Ea_i	emissions from acceleration (g/veh-m)				
11	Ed_i	emissions from deceleration (g/veh-m)				
12	Qad_i	emission rate from acceleration and deceleration (g/m-s)				
13	Lad_i	Length of acceleration and deceleration (m)				
14	Le_i	Length over which excess emissions apply (m)				
15	Fs_i	Average idling emission rate (g/s)				
16	Qe	Average emission rate (g/m-s)				
17	Qe_i	Adjusted excess emission rate (g/s-m)				
18	Qfc_i	Free-flow emission rate (g/s-m)				

* Overcapacity $Lq_i = 6(V_i - C_i)/2M_i$

WORKSHEET 2 - LINE SOURCE EMISSION RATE COMPUTATION

Intersection Purchase / Congress

Case # 3 Year 1994 Averaging Time 8 Hour

Step	Symbol	Input/Units	Traffic Stream			
1	i	Road segment (or approach identification)	PSL	PSS	CE	
2	V_i	Demand volume (vph)	615	827	1671	
3	C_i	Free-flow capacity (vph)				
4	S_i	Cruise speed (mph)	25	25	25	
5	Ef_i	Free-flow emissions (g/veh-m)				
6.1	M_i	Number of lanes in approach i	1	2	4	
6.2	j	Signalized intersections phase identification	ØD	ØB	ØC	
6.3	$Cs_{i,j}$	Capacity service volume of approach i for phase j (vph of green)	3400	4100	7000	
6.4	$V_{i,j}$	Demand volume for approach i, phase j (vph)	615	827	1671	
6.5	C_y	Signal cycle length (s)	90			
6.6	$G_{i,j}$	Green phase length for approach i, phase j (s)	52	36	38	
6.7	C_i	Capacity of approach i·(vph))	1964	1640	2956	
6.8	$P_{i,j}$	Proportion of vehicles that stop	0.52	0.75	.76	
6.9	$N_{i,j}$	Number of vehicles that stop per signal cycle	7.93	15.5	31.[illegible]	
7	N_i	Average number of vehicles in queue at four way stop or two-way stop or end of green phase	0.46	1.02	[illegible]	
8	Lq_i	Length of vehicle queue for approach i (veh-m/lane)	50.3	49.7	49.5	
9	Rq_i	Average excess running time on approach (s/veh)				
10	Ea_i	emissions from acceleration (g/veh-m)				
11	Ed_i	emissions from deceleration (g/veh-m)				
12	Qad_i	emission rate from acceleration and deceleration (g/m-s)				
13	Lad_i	Length of acceleration and deceleration (m)				
14	Le_i	Length over which excess emissions apply (m)				
15	Fs_i	Average idling emission rate (g/s)				
16	Qe	Average emission rate (g/m-s)				
17	Qe_i	Adjusted excess emission rate (g/s-m)				
18	Qfc_i	Free-flow emission rate (g/s-m)				

WORKSHEET 1 - TRAFFIC INFORMATION

Intersection Congress/Atlantic

Case # 1 Year 1986

		CES*	CEL*	AN*	CW*
1.	Road segment or intersection approach identification	CES*	CEL*	AN*	CW*
2.	Observed 1-hr volume (vph)	673	663	1262	640
	Observed 8-hr volume (vph)	552	544	[illegible]	525
	Projected 1-hr peak demand (vph)				
	Projected 8-hr peak demand (vph)				
3.	Percentage cold starts	50.0/20.6			
4.	Percentage trucks and buses	11.7%			
5.	Metropolitan population				
6.	Slope				
7.	Free-flow parameters				
	Number of lanes	2	2	3	2
	Average lane width (ft)	12.5	13	16.7	15
	Design speed (mph)			17/25	
	Highway type (see Figures 2-5)				
8.	Intersection parameters				
	Intersection designation				
	Approach width (ft)	25	26	50	30
	Percentage right turns	0	0	7	100
	Percentage left turns	0	100	0	0
	Type control and description of signal controller	[illegible]			
9.	Area source parameters				
	Parking lot gate designation				
	Projected 1-hr peak entrance demand (vph)				
	Projected 1-hr peak exit demand (vph)				
	Projected 8-hr peak entrance demand (vph)				
	Projected 8-hr peak exit demand (vph)				
	Parking lot area (m^2)				
	Parking lot capacity (veh)				
	Running time required to access auxiliary parking (s)				
	Facility emptying time				
	Average cars per stall				
	Average area per stall (m^2)				

* CES = Congress St EB - Straight
CEL = " " - Left
AN Atlantic Ave - NB
CW = Congress St WB

WORKSHEET 1 - TRAFFIC INFORMATION

Intersection [illegible]/Atlantic

Case # 2 Year 1994 - No Bld.

1.	Road segment or intersection approach identification	CES	CEL	f	N		[illegible]	
2.	Observed 1-hr volume (vph)							
	Observed 8-hr volume (vph)							
	Projected 1-hr peak demand (vph)	1272	1025	1226			643	
	Projected 8-hr peak demand (vph)	1043	841	1005			525	
3.	Percentage cold starts		50%	/20.6				
4.	Percentage trucks and buses		11.7%					
5.	Metropolitan population							
6.	Slope							
7.	Free-flow parameters							
	Number of lanes	2	2		3		2	
	Average lane width (ft)	12.5	13		16.4		15	
	Design speed (mph)	—	—	17/25			—	
	Highway type (see Figures 2-5)							
8.	Intersection parameters							
	Intersection designation							
	Approach width (ft)	25	26	50			32	
	Percentage right turns	6	0	19			[illegible]	
	Percentage left turns	0	100	9			-	
	Type control and description of signal controller	[illegible]						
9.	Area source parameters							
	Parking lot gate designation							
	Projected 1-hr peak entrance demand (vph)							
	Projected 1-hr peak exit demand (vph)							
	Projected 8-hr peak entrance demand (vph)							
	Projected 8-hr peak exit demand (vph)							
	Parking lot area (m^2)							
	Parking lot capacity (veh)							
	Running time required to access auxiliary parking (s)							
	Facility emptying time							
	Average cars per stall							
	Average area per stall (m^2)							

WORKSHEET 1 - TRAFFIC INFORMATION

Intersection Congress/Atlantic

Case # 3 Year 1995 - Build

1. Road segment or intersection approach identification	CES	CEL	AN			CW	
2. Observed 1-hr volume (vph)							
Observed 8-hr volume (vph)							
Projected 1-hr peak demand (vph)	1303	1168	1226			620	
Projected 8-hr peak demand (vph)	1069	955	1005			575	
3. Percentage cold starts		50.0/20.6					
4. Percentage trucks and buses			11.7%				
5. Metropolitan population							
6. Slope							
7. Free-flow parameters							
Number of lanes	2	2	3			2	
Average lane width (ft)	12.5	13.	16.7			15	
Design speed (mph)							
Highway type (see Figures 2-5)							
8. Intersection parameters							
Intersection designation							
Approach width (ft)	25	26		50		30	
Percentage right turns	0	0		17		100	
Percentage left turns	0	100		0		0	
Type control and description of signal controller	Signalized						
9. Area source parameters							
Parking lot gate designation							
Projected 1-hr peak entrance demand (vph)							
Projected 1-hr peak exit demand (vph)							
Projected 8-hr peak entrance demand (vph)							
Projected 8-hr peak exit demand (vph)							
Parking lot area (m^2)							
Parking lot capacity (veh)							
Running time required to access auxiliary parking (s)							
Facility emptying time							
Average cars per stall							
Average area per stall (m^2)							

WORKSHEET B - CAPACITY ANALYSIS

Intersection Congress/[illegible]

Case # 1 Year 19[illegible]

Step	Symbol	Input/Units					
1	i	Road segment (or approach) designation	CES	CEL	AN	CW	
2		Free flow capacity computation:					
2.1	M_i	Number of lanes					
2.2	W_f	Adjustment for lane width (Table B-1)					
2.3	T_i	Adjustment for trucks (Table B-2)					
2.4	C_i	Free flow capacity					
3		Signalized intersection capacity:					
3.1	j	Green signal phase identification	ϕ_D	ϕ_A	ϕ_B	ϕ_C	
3.2	Wa_i	Approach width with parking (ft)	33	34	50	30	
3.3		Percent right turners	0	0	7-16	100	
3.4		Percent left turners	0	0	0	0	
3.5		Metropolitan area size	2.5 M.				
3.6	$Cs_{i,j}$	Capacity service volume (vph or green)	3500	3800	5400	2700	(8 hr)
			3150	3420	4860	2430	(1 hr)**
4		Signalized intersection green phase and cycle length:					
4.1	$V_{i,j}$	Demand Volume for approach and phase					
4.2	$V_{i,j}/Cs_{i,j})$	Volume to green capacity ratio					
4.3	approx G/Cy	Approximate G/Cy					
4.4	$\Sigma_j \max(V_{i,j}/Cs_{i,j})$	Sum of the maximum V/C ratios for each signal phase					
4.5	Cy	Signal cycle time (sec)					
4.6	Gj	Green phase length					
4.7	Gj/Cy	Green phase to cycle time ratio					
4.8	$C_{i,j}$	Capacity for approach i phase j					
5		Two-way stop, two-way yield or uncontrolled intersection:					
5.1	V_m+V_n	Major street two-way volume					
5.2	C_i	Cross street capacity					
6		Four-way stop intersections:					
6.1	V_i	Approach volume					
6.2	Spi	Demand split on cross streets					
6.3	C_i	Capacity of approach					
7	C_i	Approach capacity $\Sigma_j C_{i,j}$ 5.2 for a four-way stop or 6.3 for a two-way stop					

* $\phi_D = \phi_A + \phi_C = 53$ sec.

** Capacity reduced by 10% during peak 1 hour to account for pedestrian activity.

WORKSHEET 2 - LINE SOURCE EMISSION RATE COMPUTATION

Intersection Congress/Atlantic

Case # 1 Year 1996 Averaging Time 1 Hour

Step	Symbol	Input/Units	Traffic Stream			
1	i	Road segment (or approach identification)	CES	CEL	AN	CW
2	V_i	Demand volume (vph)	673	663	1262	640
3	C_i	Free-flow capacity (vph)				
4	S_i	Cruise speed (mph)	17	17	17	17
5	Ef_i	Free-flow emissions (g/veh-m)				
6.1	M_i	Number of lanes in approach i	2	2	3	2
6.2	j	Signalized intersections phase identification	ϕ_D	ϕ_A	ϕ_B	ϕ_C
6.3	$Cs_{i,j}$	Capacity service volume of approach i for phase j (vph of green)	3150	3420	4860	2430
6.4	$V_{i,j}$	Demand volume for approach i, phase j (vph)	673	663	1262	640
6.5	C_y	Signal cycle length (s)	80			
6.6	$G_{i,j}$	Green phase length for approach i, phase j (s)	53	25	27	28
6.7	C_i	Capacity of approach i·(vph))	2087	1069	1823	945
6.8	$P_{i,j}$	Proportion of vehicles that stop	0.43	0.85	0.87	0.85
6.9	$N_{i,j}$	Number of vehicles that stop per signal cycle	6.4	12.6	24.3	12.1
7	N_i	Average number of vehicles in queue at four way stop or two-way stop or end of green phase	0.5	1.6	23	21
8	Lq_i	Length of vehicle queue for approach i (veh-m/lane)	20.7	42.6	53.0	42.6
9	Rq_i	Average excess running time on approach (s/veh)				
10	Ea_i	emissions from acceleration (g/veh-m)				
11	Ed_i	emissions from deceleration (g/veh-m)				
12	Qad_i	emission rate from acceleration and deceleration (g/m-s)				
13	Lad_i	Length of acceleration and deceleration (m)				
14	Le_i	Length over which excess emissions apply (m)				
15	Fs_i	Average idling emission rate (g/s)				
16	Qe	Average emission rate (q/m-s)				
17	Qe_i	Adjusted excess emission rate (g/s-m)				
18	Qfc_i	Free-flow emission rate (g/s-m)				

WORKSHEET 2 - LINE SOURCE EMISSION RATE COMPUTATION

Intersection Cypress/Atlantic

Case # 1 Year 1986 Averaging Time 8 Hour

Step	Symbol	Input/Units	Traffic Stream			
1	i	Road segment (or approach identification)	CES	CEL	AN	CW
2	V_i	Demand volume (vph)	552	544	1035	525
3	C_i	Free-flow capacity (vph)				
4	S_i	Cruise speed (mph)	25	25	25	25
5	Ef_i	Free-flow emissions (g/veh-m)				
6.1	M_i	Number of lanes in approach i	2	2	3	2
6.2	j	Signalized intersections phase identification	ϕ_D	ϕ_A	ϕ [illegible]	ϕ [illegible]
6.3	$Cs_{i,j}$	Capacity service volume of approach i for phase j (vph of green)	3500	3300	5400	2700
6.4	$V_{i,j}$	Demand volume for approach i, phase j (vph)	552	544	1035	525
6.5	C_y	Signal cycle length (s)	80			
6.6	$G_{i,j}$	Green phase length for approach i, phase j (s)	53	25	27	28
6.7	C_i	Capacity of approach i·(vph))	2319	1188	1823	945
6.8	$P_{i,j}$	Proportion of vehicles that stop	0.40	0.80	0.82	0.81
6.9	$N_{i,j}$	Number of vehicles that stop per signal cycle	4.9	9.7	18.9	9.4
7	N_i	Average number of vehicles in queue at four way stop or two-way stop or end of green phase	0.3	0.9	1.3	1.3
8	Lq_i	Length of vehicle queue for approach i (veh-m/lane)	15.7	31.6	40.3	32.0
9	Rq_i	Average excess running time on approach (s/veh)				
10	Ea_i	emissions from acceleration (g/veh-m)				
11	Ed_i	emissions from deceleration (g/veh-m)				
12	Qad_i	emission rate from acceleration and deceleration (g/m-s)				
13	Lad_i	Length of acceleration and deceleration (m)				
14	Le_i	Length over which excess emissions apply (m)				
15	Fs_i	Average idling emission rate (g/s)				
16	Qe	Average emission rate (q/m-s)				
17	Qe_i	Adjusted excess emission rate (g/s-m)				
18	Qfc_i	Free-flow emission rate (g/s-m)				

WORKSHEET 2 - LINE SOURCE EMISSION RATE COMPUTATION

Intersection [illegible]

Case # 7 Year 1994 Averaging Time 1-Hour

Step	Symbol	Input/Units	Traffic Stream			
1	i	Road segment (or approach identification)	CES	CEL	AN	CW
2	V_i	Demand volume (vph)	1272	1025	1226	640
3	C_i	Free-flow capacity (vph)				
4	S_i	Cruise speed (mph)	17	17	17	[illegible]
5	Ef_i	Free-flow emissions (g/veh-m)				
6.1	M_i	Number of lanes in approach i	2	[illegible]	3	2
6.2	j	Signalized intersections phase identification	ϕ_D	ϕ_A	ϕ_B	ϕ_C
6.3	$Cs_{i,j}$	Capacity service volume of approach i for phase j (vph of green)	3150	3420	4860	2430
6.4	$V_{i,j}$	Demand volume for approach i, phase j (vph)	1272	1025	1226	[illegible]
6.5	C_y	Signal cycle length (s)	80			
6.6	$G_{i,j}$	Green phase length for approach i, phase j (s)	53	25	27	28
6.7	C_i	Capacity of approach i·(vph))	2087	1069	1640	851
6.8	$P_{i,j}$	Proportion of vehicles that stop	0.57	0.98	0.89	0.78
6.9	$N_{i,j}$	Number of vehicles that stop per signal cycle	16.0	22.4	24.1	12.6
7	N_i	Average number of vehicles in queue at four way stop or two-way stop or end of green phase	1.6	23.4	3.0	3.0
8	Lq_i	Length of vehicle queue for approach i (veh-m/lane)	52.7	137	54.2	46.8
9	Rq_i	Average excess running time on approach (s/veh)				
10	Ea_i	emissions from acceleration (g/veh-m)				
11	Ed_i	emissions from deceleration (g/veh-m)				
12	Qad_i	emission rate from acceleration and deceleration (g/m-s)				
13	Lad_i	Length of acceleration and deceleration (m)				
14	Le_i	Length over which excess emissions apply (m)				
15	Fs_i	Average idling emission rate (g/s)				
16	Qe	Average emission rate (g/m-s)				
17	Qe_i	Adjusted excess emission rate (g/s-m)				
18	Qfc_i	Free-flow emission rate (g/s-m)				

** Overcapacity - Use NCHRP - $Lq_i = 6(V_i - C_i)/2m_i$

WORKSHEET 2 - LINE SOURCE EMISSION RATE COMPUTATION

Intersection [illegible]

Case # 2 Year [illegible] Averaging Time 8 Hour

Step	Symbol	Input/Units	Traffic Stream			
1	i	Road segment (or approach identification)	CES	CEL	AN	CW
2	V_i	Demand volume (vph)	1043	841	1005	525
3	C_i	Free-flow capacity (vph)				
4	S_i	Cruise speed (mph)	25	25	25	25
5	Ef_i	Free-flow emissions (g/veh-m)				
6.1	M_i	Number of lanes in approach i	2	2	3	2
6.2	j	Signalized intersections phase identification	ϕ_D	ϕ_A	ϕ_B	ϕ_C
6.3	$Cs_{i,j}$	Capacity service volume of approach i for phase j (vph of green)	3500	3800	5400	2700
6.4	$V_{i,j}$	Demand volume for approach i, phase j (vph)	1043	841	1005	525
6.5	C_y	Signal cycle length (s)	80			
6.6	$G_{i,j}$	Green phase length for approach i, phase j (s)	53	25	27	28
6.7	C_i	Capacity of approach i·(vph))	2319	1188	1823	945
6.8	$P_{i,j}$	Proportion of vehicles that stop	0.48	0.88	0.81	0.81
6.9	$N_{i,j}$	Number of vehicles that stop per signal cycle	11.1	16.5	18.2	9.4
7	N_i	Average number of vehicles in queue at four way stop or two-way stop or end of green phase	0.8	2.4	1.2	1.3
8	Lq_i	Length of vehicle queue for approach i (veh-m/lane)	35.9	56.8	38.8	32.0
9	Rq_i	Average excess running time on approach (s/veh)				
10	Ea_i	emissions from acceleration (g/veh-m)				
11	Ed_i	emissions from deceleration (g/veh-m)				
12	Qad_i	emission rate from acceleration and deceleration (g/m-s)				
13	Lad_i	Length of acceleration and deceleration (m)				
14	Le_i	Length over which excess emissions apply (m)				
15	Fs_i	Average idling emission rate (g/s)				
16	Qe	Average emission rate (g/m-s)				
17	Qe_i	Adjusted excess emission rate (g/s-m)				
18	Qfc_i	Free-flow emission rate (g/s-m)				

WORKSHEET 2 - LINE SOURCE EMISSION RATE COMPUTATION

Intersection Congress/Atlantic

Case # 3 Year 199[illegible] Averaging Time 1 Hour

Step	Symbol	Input/Units	Traffic Stream			
1	i	Road segment (or approach identification)	CES	CEL	AN	CW
2	V_i	Demand volume (vph)	1303	1168	1226	640
3	C_i	Free-flow capacity (vph)				
4	S_i	Cruise speed (mph)	17	17	17	17
5	Ef_i	Free-flow emissions (g/veh-m)				
6.1	M_i	Number of lanes in approach i	2	2	3	2
6.2	j	Signalized intersections phase identification	ϕ_D	ϕ_A	ϕ_B	ϕ_C
6.3	$Cs_{i,j}$	Capacity service volume of approach i for phase j (vph of green)	3150	3420	4860	2430
6.4	$V_{i,j}$	Demand volume for approach i, phase j (vph)	1303	1168	1226	640
6.5	C_y	Signal cycle length (s)	80			
6.6	$G_{i,j}$	Green phase length for approach i, phase j (s)	53	25	27	28
6.7	C_i	Capacity of approach i (vph)	2087	1069*	1640	851
6.8	$P_{i,j}$	Proportion of vehicles that stop	0.56		0.89	0.88
6.9	$N_{i,j}$	Number of vehicles that stop per signal cycle	16.7		24.1	12.6
7	N_i	Average number of vehicles in queue at four way stop or two-way stop or end of green phase	1.7		3.0	3.0
8	Lq_i	Length of vehicle queue for approach i (veh-m/lane)	55.0	149	54.2	46.8
9	Rq_i	Average excess running time on approach (s/veh)				
10	Ea_i	emissions from acceleration (g/veh-m)				
11	Ed_i	emissions from deceleration (g/veh-m)				
12	Qad_i	emission rate from acceleration and deceleration (g/m-s)				
13	Lad_i	Length of acceleration and deceleration (m)				
14	Le_i	Length over which excess emissions apply (m)				
15	Fs_i	Average idling emission rate (g/s)				
16	Qe	Average emission rate (g/m-s)				
17	Qe_i	Adjusted excess emission rate (g/s-m)				
18	Qfc_i	Free-flow emission rate (g/s-m)				

* Over-capacity - Use NCHRP - $Lq_i = 6(V_i - C_i)$ 2 min.

WORKSHEET 2 - LINE SOURCE EMISSION RATE COMPUTATION

Intersection [illegible]

Case # 3 Year 19[illegible] Averaging Time 8 Hour

Step	Symbol	Input/Units	Traffic Stream			
1	i	Road segment (or approach identification)	CES	CEL	AN	CW
2	V_i	Demand volume (vph)	1069	955	1005	525
3	C_i	Free-flow capacity (vph)				
4	S_i	Cruise speed (mph)	25	25	25	25
5	Ef_i	Free-flow emissions (g/veh-m)				
6.1	M_i	Number of lanes in approach i	2	2	3	2
6.2	j	Signalized intersections phase identification	ϕ_2	ϕ_4	ϕ_3	ϕ_6
6.3	$Cs_{i,j}$	Capacity service volume of approach i for phase j (vph of green)	3500	3800	5400	2700
6.4	$V_{i,j}$	Demand volume for approach i, phase j (vph)	1069	955	1005	525
6.5	C_y	Signal cycle length (s)	80			
6.6	$G_{i,j}$	Green phase length for approach i, phase j (s)	53	25	27	28
6.7	C_i	Capacity of approach i·(vph))	2319	1188	1823	945
6.8	$P_{i,j}$	Proportion of vehicles that stop	0.49	0.92	0.81	0.81
6.9	$N_{i,j}$	Number of vehicles that stop per signal cycle	11.5	19.5	18.2	9.4
7	N_i	Average number of vehicles in queue at four way stop or two-way stop or end of green phase	0.9	4.1	1.2	1.3
8	Lq_i	Length of vehicle queue for approach i (veh-m/lane)	37.2	70.8	38.8	32.0
9	Rq_i	Average excess running time on approach (s/veh)				
10	Ea_i	emissions from acceleration (g/veh-m)				
11	Ed_i	emissions from deceleration (g/veh-m)				
12	Qad_i	emission rate from acceleration and deceleration (g/m-s)				
13	Lad_i	Length of acceleration and deceleration (m)				
14	Le_i	Length over which excess emissions apply (m)				
15	Fs_i	Average idling emission rate (g/s)				
16	Qe	Average emission rate (g/m-s)				
17	Qe_i	Adjusted excess emission rate (g/s-m)				
18	Qfc_i	Free-flow emission rate (g/s-m)				

WORKSHEET 1 - TRAFFIC INFORMATION

Intersection Atlantic Ave / Surface Artery

Case # 1 Year 1986

1.	Road segment or intersection approach identification	SN	ANL	ANS	AS	SS	SSR
2.	Observed 1-hr volume (vph)	1154	326	397	418	603	86
	Observed 8-hr volume (vph)	946	267	326.	343	495	71
	Projected 1-hr peak demand (vph)						
	Projected 8-hr peak demand (vph)						
3.	Percentage cold starts						
4.	Percentage trucks and buses	5% →					
5.	Metropolitan population						
6.	Slope						
7.	Free-flow parameters						
	Number of lanes	2	1	1	3	3	1
	Average lane width (ft)	18	15	15	11.33	11.33	11.33
	Design speed (mph)						
	Highway type (see Figures 2-5)	Urban Artery.					
8.	Intersection parameters						
	Intersection designation						
	Approach width (ft)						
	Percentage right turns						
	Percentage left turns						
	Type control and description of signal controller						
9.	Area source parameters						
	Parking lot gate designation						
	Projected 1-hr peak entrance demand (vph)						
	Projected 1-hr peak exit demand (vph)						
	Projected 8-hr peak entrance demand (vph)						
	Projected 8-hr peak exit demand (vph)						
	Parking lot area (m^2)						
	Parking lot capacity (veh)						
	Running time required to access auxiliary parking (s)						
	Facility emptying time						
	Average cars per stall						
	Average area per stall (m^2)						

SN = Surface Artery. NB

ANL = Atlantic Ave - NB - Left Turn Lane

ANS = " " - Straight.

AS = " " SB

SS = Surface Artery - SB.

WORKSHEET 1 - TRAFFIC INFORMATION

Intersection Atlantic Ave / Surface Artery

Case # 2 Year 1994 -No Build

1. Road segment or intersection approach identification	SN		ANL		ANS	AS	SS	SSR
2. Observed 1-hr volume (vph)								
Observed 8-hr volume (vph)								
Projected 1-hr peak demand (vph)	2083		449		409	418	767	336
Projected 8-hr peak demand (vph)	1708		362		335	343	629	276
3. Percentage cold starts								
4. Percentage trucks and buses	5%							
5. Metropolitan population								
6. Slope								
7. Free-flow parameters								
Number of lanes	2		1		1	3	3	1
Average lane width (ft)	18		15		15	11.33	11.33	11.33
Design speed (mph)								
Highway type (see Figures 2-5)		Urban Artery.						
8. Intersection parameters								
Intersection designation								
Approach width (ft)								
Percentage right turns								
Percentage left turns								
Type control and description of signal controller								
9. Area source parameters								
Parking lot gate designation								
Projected 1-hr peak entrance demand (vph)								
Projected 1-hr peak exit demand (vph)								
Projected 8-hr peak entrance demand (vph)								
Projected 8-hr peak exit demand (vph)								
Parking lot area (m^2)								
Parking lot capacity (veh)								
Running time required to access auxiliary parking (s)								
Facility emptying time								
Average cars per stall								
Average area per stall (m^2)								

WORKSHEET 1 - TRAFFIC INFORMATION

Intersection Atlantic Ave / Surface Artery

Case # 3 Year 1994 – Build

1.	Road segment or intersection approach identification	SN		ANL		ANS	AS	SS	SSR
2.	Observed 1-hr volume (vph)								
	Observed 8-hr volume (vph)	-		-					
	Projected 1-hr peak demand (vph)	2469		471		414	418	822	336
	Projected 8-hr peak demand (vph)	2028		386		225	343	674	276
3.	Percentage cold starts								
4.	Percentage trucks and buses		5% →						
5.	Metropolitan population								
6.	Slope								
7.	Free-flow parameters								
	Number of lanes	2		1		1	3	3	1
	Average lane width (ft)	18		15		15	11.33	11.33	11.33
	Design speed (mph)								
	Highway type (see Figures 2-5)		Urban Artery						
8.	Intersection parameters								
	Intersection designation								
	Approach width (ft)								
	Percentage right turns								
	Percentage left turns								
	Type control and description of signal controller								
9.	Area source parameters								
	Parking lot gate designation								
	Projected 1-hr peak entrance demand (vph)								
	Projected 1-hr peak exit demand (vph)								
	Projected 8-hr peak entrance demand (vph)								
	Projected 8-hr peak exit demand (vph)								
	Parking lot area (m^2)								
	Parking lot capacity (veh)								
	Running time required to access auxiliary parking (s)								
	Facility emptying time								
	Average cars per stall								
	Average area per stall (m^2)								

WORKSHEET B - CAPACITY ANALYSIS

Intersection: Atlantic Ave / Surface Artery

Case # 1 Year 1986

Step	Symbol	Input/Units								
1	i	Road segment (or approach) designation	SN		ANL	ANS		AS	SS	
2		Free flow capacity computation:								
2.1	M_i	Number of lanes								
2.2	W_f	Adjustment for lane width (Table B-1)								
2.3	T_i	Adjustment for trucks (Table B-2)								
2.4	C_i	Free flow capacity								
3		Signalized intersection capacity:								
3.1	j	Green signal phase identification	C	D	B	C	B	A	D	
3.2	Wa_i	Approach width with parking (ft)	44	44	23	23	23	41	41	
3.3		Percent right turners	0	0	0	0	0	0	6	
3.4		Percent left turners	0	31	0	6	0	0	0	
3.5		Metropolitan area size	2.5M							
3.6	$Cs_{i,j}$	Capacity service volume (vph or green)	4700	4000	2300	2300	2300	4100	4100	8 HR
			4465	3800	2185	2185	2185	3895	3895	1 HR
4		Signalized intersection green phase and cycle length:								
4.1	$V_{i,j}$	Demand Volume for approach and phase								
4.2	$V_{i,j}/Cs_{i,j})$	Volume to green capacity ratio								
4.3	approx G/Cy	Approximate G/Cy								
4.4	$\Sigma_j \max(V_{i,j} Cs_{i,j})$	Sum of the maximum V/C ratios for each signal phase								
4.5	Cy	Signal cycle time (sec)								
4.6	Gj	Green phase length								
4.7	Gj/Cy	Green phase to cycle time ratio								
4.8	$C_{i,j}$	Capacity for approach i phase j								
5		Two-way stop, two-way yield or uncontrolled intersection:	SSR							
5.1	V_m+V_n	Major street two-way volume	573 / 470							
5.2	C_i	Cross street capacity (1hr/3hr)	547 / 588							
6		Four-way stop intersections:								
6.1	V_i	Approach volume								
6.2	Spi	Demand split on cross streets								
6.3	C_i	Capacity of approach								
7	C_i	Approach capacity $\Sigma_j C_{i,j}$ 5.2 for a four-way stop or 6.3 for a two-way stop								

$$C_i = \frac{(V_m + V_n)\, e^{-a}}{1 - e^{-a}}$$

, a = 573 (4.5)/3600 = 0.716, C_i = 547

, a = 470 (4.5)/3600 = 0.587, C_i = 588

WORKSHEET B - CAPACITY ANALYSIS

Intersection Atlantic Ave/ Surface Artery

Case # 2 & 3 Year 1990 - No Build

Step	Symbol	Input/Units	
1	i	Road segment (or approach) designation	SN ANL ANS AS SS
2		Free flow capacity computation:	
2.1	M_i	Number of lanes	
2.2	W_f	Adjustment for lane width (Table B-1)	
2.3	T_i	Adjustment for trucks (Table B-2)	
2.4	C_i	Free flow capacity	
3		Signalized intersection capacity:	
3.1	j	Green signal phase identification	C D B C B A D
3.2	Wa_i	Approach width with parking (ft)	44 44 23 23 23 41 41
3.3		Percent right turners	0 0 0 0 0 0 0
3.4		Percent left turners	0 38 45 0 0 0 0 0
3.5		Metropolitan area size	2.5 M
3.6	$Cs_{i,j}$	Capacity service volume (vph or green)	4700 4050 2300 2300 2300 4100 4100 / 4465 3800 2185 2185 2185 3895 3895
4		Signalized intersection green phase and cycle length:	
4.1	$V_{i,j}$	Demand Volume for approach and phase	
4.2	$V_{i,j}/Cs_{i,j})$	Volume to green capacity ratio	
4.3	approx G/Cy	Approximate G/Cy	
4.4	$\Sigma_j \max(V_{i,j}Cs_{i,j})$	Sum of the maximum V/C ratios for each signal phase	
4.5	Cy	Signal cycle time (sec)	
4.6	Gj	Green phase length	
4.7	Gj/Cy	Green phase to cycle time ratio	
4.8	$C_{i,j}$	Capacity for approach i phase j	
5		Two-way stop, two-way yield or uncontrolled intersection:	SSR
5.1	V_m+V_n	Major street two-way volume	820 / 672
5.2	C_i	Cross street capacity (1hr/8hr)	459 / 510
6		Four-way stop intersections:	
6.1	V_i	Approach volume	
6.2	Spi	Demand split on cross streets	
6.3	C_i	Capacity of approach	
7	C_i	Approach capacity $\Sigma_j C_{i,j}$ 5.2 for a four-way stop or 6.3 for a two-way stop	

1hr - a = 820 (4.5)/3600 = 1.025 C_i = 459

8hr - a = 672 (4.5)/3600 = 0.84 C_i = 510

WORKSHEET 2 - LINE SOURCE EMISSION RATE COMPUTATION

Intersection Atlantic Ave / Surface Artery.

Case # 1 Year 1986 Averaging Time 1 Hour

Step	Symbol	Input/Units	Traffic Stream	
1	i	Road segment (or approach identification)	SN ANL ANS AS | SS	SSR
2	V_i	Demand volume (vph)	1154 326 397 418 | 603	86
3	C_i	Free-flow capacity (vph)		
4	S_i	Cruise speed (mph)	17	
5	Ef_i	Free-flow emissions (g/veh-m)		
6.1	M_i	Number of lanes in approach i	2 1 1 3 3	1
6.2	j	Signalized intersections phase identification	C D B C B A D	* Stop
6.3	$Cs_{i,j}$	Capacity service volume of approach i for phase j (vph of green)	4465 3800 2185 2185 2235 3855 3855	547
6.4	$V_{i,j}$	Demand volume for approach i, phase j (vph)	239 915 326 133 264 418 603	86
6.5	C_y	Signal cycle length (s)	100	
6.6	$G_{i,j}$	Green phase length for approach i, phase j (s)	12 46 24 12 24 18 46	
6.7	C_i	Capacity of approach i (vph))	2284 524 787 701 1792	
6.8	$P_{i,j}$	Proportion of vehicles that stop	0.93 0.71 0.89 0.94 0.86 0.92 0.64	
6.9	$N_{i,j}$	Number of vehicles that stop per signal cycle	6.2 18.1 8.1 3.5 6.3 10.7 10.7	
7	N_i	Average number of vehicles in queue at four way stop or two-way stop or end of green phase	1.0 1.6 1.0 1.5 0.5	
8	Lq_i	Length of vehicle queue for approach i (veh-m/lane)	76 58 65 24 22	1.1
9	Rq_i	Average excess running time on approach (s/veh)		
10	Ea_i	emissions from acceleration (g/veh-m)		
11	Ed_i	emissions from deceleration (g/veh-m)		
12	Qad_i	emission rate from acceleration and deceleration (g/m-s)		
13	Lad_i	Length of acceleration and deceleration (m)		
14	Le_i	Length over which excess emissions apply (m)		
15	Fs_i	Average idling emission rate (g/s)		
16	Qe	Average emission rate (g/m-s)		
17	Qe_i	Adjusted excess emission rate (g/s-m)		
18	Qfc_i	Free-flow emission rate (g/s-m)		

WORKSHEET 2 - LINE SOURCE EMISSION RATE COMPUTATION

Intersection Atlantic Ave/ Surface Artery

Case # 1 Year 1986 Averaging Time 8 Hour

Step	Symbol	Input/Units	Traffic Stream	
1	i	Road segment (or approach identification)	SN ANL ANS AS SS	SSR
2	V_i	Demand volume (vph)	946 267 326 343 495	71
3	C_i	Free-flow capacity (vph)		
4	S_i	Cruise speed (mph)	25	
5	Ef_i	Free-flow emissions (g/veh-m)		
6.1	M_i	Number of lanes in approach i	2 1 1 3 3	1
6.2	j	Signalized intersections phase identification	C D B C B A D	Stop
6.3	$Cs_{i,j}$	Capacity service volume of approach i for phase j (vph of green)	4750 4510 2300 2330 2310 4100 4100	588
6.4	$V_{i,j}$	Demand volume for approach i, phase j (vph)	196 750 267 108 218 343 495	71
6.5	C_y	Signal cycle length (s)	100	
6.6	$G_{i,j}$	Green phase length for approach i, phase j (s)	12 46 24 12 24 18 46	
6.7	C_i	Capacity of approach i (vph)	2404 552 828 738	
6.8	$P_{i,j}$	Proportion of vehicles that stop	0.92 0.67 0.86 0.92 0.84 0.9 0.6	
6.9	$N_{i,j}$	Number of vehicles that stop per signal cycle	5.0 13.9 6.4 2.8 5.1 8.5 8.5	
7	N_i	Average number of vehicles in queue at four way stop or two-way stop or end of green phase	0.7 0.9 0.7 0.9 0.4	
8	Lq_i	Length of vehicle queue for approach i (veh-m/lane)	58.5 43.9 51.0 18.8 17.0	0.8
9	Rq_i	Average excess running time on approach (s/veh)		
10	Ea_i	emissions from acceleration (g/veh-m)		
11	Ed_i	emissions from deceleration (g/veh-m)		
12	Qad_i	emission rate from acceleration and deceleration (g/m-s)		
13	Lad_i	Length of acceleration and deceleration (m)		
14	Le_i	Length over which excess emissions apply (m)		
15	Fs_i	Average idling emission rate (g/s)		
16	Qe	Average emission rate (g/m-s)		
17	Qe_i	Adjusted excess emission rate (g/s-m)		
18	Qfc_i	Free-flow emission rate (g/s-m)		

WORKSHEET 2 - LINE SOURCE EMISSION RATE COMPUTATION

Intersection Atlantic Ave/ Surface Artery

Case # 2 Year [illegible] Averaging Time 1 Hour

Step	Symbol	Input/Units	Traffic Stream	
1	i	Road segment (or approach identification)	SN ANL ANS AS SS	SSR
2	V_i	Demand volume (vph)	2083 441 409 418 767	336
3	C_i	Free-flow capacity (vph)		
4	S_i	Cruise speed (mph)	17	
5	Ef_i	Free-flow emissions (g/veh-m)		
6.1	M_i	Number of lanes in approach i	2 1 1 3 3	1
6.2	j	Signalized intersections phase identification	C D B C B A D	stop
6.3	$Cs_{i,j}$	Capacity service volume of approach i for phase j (vph of green)	4465 3900 2185 [illegible] [illegible] 3895 3895	459
6.4	$V_{i,j}$	Demand volume for approach i, phase j (vph)	431 1652 441 136 273 418 767	336
6.5	C_y	Signal cycle length (s)	100	
6.6	$G_{i,j}$	Green phase length for approach i, phase j (s)	12 46 24 12 24 18 46	
6.7	C_i	Capacity of approach i (vph))	2284 524 787 701 1792	
6.8	$P_{i,j}$	Proportion of vehicles that stop	0.97 0.96 0.95 0.94 0.87 0.92 0.67	
6.9	$N_{i,j}$	Number of vehicles that stop per signal cycle	11.7 43.8 11.7 3.6 6.6 10.7 14.3	
7	N_i	Average number of vehicles in queue at four way stop or two-way stop or end of green phase	10.4 5.3 1.1 1.5 0.8	
8	Lq_i	Length of vehicle queue for approach i (veh-m/lane)	198 102 67 24 30	16.4
9	Rq_i	Average excess running time on approach (s/veh)		
10	Ea_i	emissions from acceleration (g/veh-m)		
11	Ed_i	emissions from deceleration (g/veh-m)		
12	Qad_i	emission rate from acceleration and deceleration (g/m-s)		
13	Lad_i	Length of acceleration and deceleration (m)		
14	Le_i	Length over which excess emissions apply (m)		
15	Fs_i	Average idling emission rate (g/s)		
16	Qe	Average emission rate (g/m-s)		
17	Qe_i	Adjusted excess emission rate (g/s-m)		
18	Qfc_i	Free-flow emission rate (g/s-m)		

WORKSHEET 2 - LINE SOURCE EMISSION RATE COMPUTATION

Intersection Atlantic Ave / Surface Artery

Case # 2 Year 1994 Averaging Time 8 Hour

Step	Symbol	Input/Units	Traffic Stream	
1	i	Road segment (or approach identification)	SN ANL ANS AS SS	SSR
2	V_i	Demand volume (vph)	1733 362 335 343 629	276
3	C_i	Free-flow capacity (vph)		
4	S_i	Cruise speed (mph)	25	
5	Ef_i	Free-flow emissions (g/veh-m)		
6.1	M_i	Number of lanes in approach i	2 1 1 3 3	1
6.2	j	Signalized intersections phase identification	C D B C B A D	Stop
6.3	$Cs_{i,j}$	Capacity service volume of approach i for phase j (vph of green)	4700 4600 2300 2300 [illegible] 4100 4100	510
6.4	$V_{i,j}$	Demand volume for approach i, phase j (vph)	353 1385 362 112 223 343 629	276
6.5	C_y	Signal cycle length (s)	100	
6.6	$G_{i,j}$	Green phase length for approach i, phase j (s)	12 46 24 12 24 18 46	
6.7	C_i	Capacity of approach i (vph)	2404 552 828 738 1886	
6.8	$P_{i,j}$	Proportion of vehicles that stop	0.95 0.82 0.90 0.93 0.84 0.9 0.6	
6.9	$N_{i,j}$	Number of vehicles that stop per signal cycle	9.3 30.7 9.1 2.9 5.2 8.5 11.1	
7	N_i	Average number of vehicles in queue at four way stop or two-way stop or end of green phase	2.5 1.9 0.7 0.9 0.5	
8	Lq_i	Length of vehicle queue for approach i (veh-m/lane)	127.6 65.8 52.6 18.8 23.3	7.1
9	Rq_i	Average excess running time on approach (s/veh)		
10	Ea_i	emissions from acceleration (g/veh-m)		
11	Ed_i	emissions from deceleration (g/veh-m)		
12	Qad_i	emission rate from acceleration and deceleration (g/m-s)		
13	Lad_i	Length of acceleration and deceleration (m)		
14	Le_i	Length over which excess emissions apply (m)		
15	Fs_i	Average idling emission rate (g/s)		
16	Qe	Average emission rate (g/m-s)		
17	Qe_i	Adjusted excess emission rate (g/s-m)		
18	Qfc_i	Free-flow emission rate (g/s-m)		

WORKSHEET 2 - LINE SOURCE EMISSION RATE COMPUTATION

Intersection: Atlantic Ave / Surface Artery

Case # 3 Year 1994 Averaging Time 1 Hour

Step	Symbol	Input/Units	Traffic Stream	
1	i	Road segment (or approach identification)	SN ANL ANS AS S	SSA
2	V_i	Demand volume (vph)	2469 471 409 418 822	336
3	C_i	Free-flow capacity (vph)		
4	S_i	Cruise speed (mph)	17	
5	Ef_i	Free-flow emissions (g/veh-m)		
6.1	M_i	Number of lanes in approach i	2 1 1 3 3	1
6.2	j	Signalized intersections phase identification	C D B C B A D	Stop
6.3	$Cs_{i,j}$	Capacity service volume of approach* i for phase j (vph of green)	4465 4000 2185 [illegible]	459
6.4	$V_{i,j}$	Demand volume for approach i, phase j (vph)	511 1958 471 136 273 418 822	336
6.5	C_y	Signal cycle length (s)	100	
6.6	$G_{i,j}$	Green phase length for approach i, phase j (s)	12 [illegible] 74 12 24 18 46	
6.7	C_i	Capacity of approach i (vph) **	2283 524 757 701 1792	
6.8	$P_{i,j}$	Proportion of vehicles that stop	0.97 .94 .41 .92 .68	
6.9	$N_{i,j}$	Number of vehicles that stop per signal cycle	12.7 [illegible] 6.6 13.7 15.6	
7	N_i	Average number of vehicles in queue at four way stop or two-way stop or end of green phase	8.8 1.1 1.5 0.9	
8	Lq_i	Length of vehicle queue for approach i (veh-m/lane)	279 129.0 67 [illegible] 33	16.4
9	Rq_i	Average excess running time on approach (s/veh)		
10	Ea_i	emissions from acceleration (g/veh-m)		
11	Ed_i	emissions from deceleration (g/veh-m)		
12	Qad_i	emission rate from acceleration and deceleration (g/m-s)		
13	Lad_i	Length of acceleration and deceleration (m)		
14	Le_i	Length over which excess emissions apply (m)		
15	Fs_i	Average idling emission rate (g/s)		
16	Qe	Average emission rate (g/m-s)		
17	Qe_i	Adjusted excess emission rate (g/s-m)		
18	Qfc_i	Free-flow emission rate (g/s-m)		

** C_i capacity – NCHRP – $Lq_i = 6(V_i - C_i)/(2M_i)$

WORKSHEET 2 - LINE SOURCE EMISSION RATE COMPUTATION

Intersection Atlantic Ave / Surface Artery

Case # 3 Year 1994 Averaging Time 8 Hour

Step	Symbol	Input/Units	Traffic Stream	
1	i	Road segment (or approach identification)	SN ANL ANS AS SS	SSR
2	V_i	Demand volume (vph)	2025 386 335 343 674	276
3	C_i	Free-flow capacity (vph)		
4	S_i	Cruise speed (mph)	25	
5	Ef_i	Free-flow emissions (g/veh-m)		
6.1	M_i	Number of lanes in approach i	2 1 1 3 3	1
6.2	j	Signalized intersections phase identification	C D B C C B A D	Stop
6.3	$Cs_{i,j}$	Capacity service volume of approach i for phase j (vph of green)	4700 4700 2300 2200 2300 2100 2100	510
6.4	$V_{i,j}$	Demand volume for approach i, phase j (vph)	411 [illegible] 386 112 223 [illegible] 674	276
6.5	C_y	Signal cycle length (s)	100	
6.6	$G_{i,j}$	Green phase length for approach i, phase j (s)	12 [illegible] 24 13 [illegible] [illegible] [illegible]	
6.7	C_i	Capacity of approach i·(vph))	2404 552 [illegible] [illegible] [illegible]	
6.8	$P_{i,j}$	Proportion of vehicles that stop	0.97 0.9 0.9 .13 .57 .10 0.6	
6.9	$N_{i,j}$	Number of vehicles that stop per signal cycle	11.3 40.3 9.8 2.9 5.2 3.6 11.1	
7	N_i	Average number of vehicles in queue at four way stop or two-way stop or end of green phase	5.3 2.3 0.7 [illegible] 0.5	
8	Lq_i	Length of vehicle queue for approach i (veh-m/lane)	170.8 72.7 [illegible] [illegible] 23.3	7.1
9	Rq_i	Average excess running time on approach (s/veh)		
10	Ea_i	emissions from acceleration (g/veh-m)		
11	Ed_i	emissions from deceleration (g/veh-m)		
12	Qad_i	emission rate from acceleration and deceleration (g/m-s)		
13	Lad_i	Length of acceleration and deceleration (m)		
14	Le_i	Length over which excess emissions apply (m)		
15	Fs_i	Average idling emission rate (g/s)		
16	Qe	Average emission rate (g/m-s)		
17	Qe_i	Adjusted excess emission rate (g/s-m)		
18	Qfc_i	Free-flow emission rate (g/s-m)		

WORKSHEET 1 - TRAFFIC INFORMATION

Intersection Atlantic/ Northern

Case # 1 Year 1986

1.	Road segment or intersection approach identification	NW *
2.	Observed 1-hr volume (vph)	540
	Observed 8-hr volume (vph)	443
	Projected 1-hr peak demand (vph)	
	Projected 8-hr peak demand (vph)	
3.	Percentage cold starts	50/20.6
4.	Percentage trucks and buses	5.5
5.	Metropolitan population	
6.	Slope	
7.	Free-flow parameters	
	Number of lanes	4
	Average lane width (ft)	12
	Design speed (mph)	17/25
	Highway type (see Figures 2-5)	Urban Artery
8.	Intersection parameters	
	Intersection designation	
	Approach width (ft)	
	Percentage right turns	100
	Percentage left turns	0
	Type control and description of signal controller	Stop Sign.
9.	Area source parameters	
	Parking lot gate designation	
	Projected 1-hr peak entrance demand (vph)	
	Projected 1-hr peak exit demand (vph)	
	Projected 8-hr peak entrance demand (vph)	
	Projected 8-hr peak exit demand (vph)	
	Parking lot area (m^2)	
	Parking lot capacity (veh)	
	Running time required to access auxiliary parking (s)	
	Facility emptying time	
	Average cars per stall	
	Average area per stall (m^2)	

* NW = Northern Ave - Westbound

WORKSHEET 1 - TRAFFIC INFORMATION

Intersection Atlantic / Northern

Case # 2 Year 1994 - No Build.

		ANS*	ANR*	NW*	RE*
1.	Road segment or intersection approach identification	ANS*	ANR*	NW*	RE*
2.	Observed 1-hr volume (vph)				
	Observed 8-hr volume (vph)				
	Projected 1-hr peak demand (vph)	995	1183	664	801
	Projected 8-hr peak demand (vph)	816	970	545	657
3.	Percentage cold starts	50/20.6			
4.	Percentage trucks and buses	6.0	6.0	18	6.0
5.	Metropolitan population				
6.	Slope				
7.	Free-flow parameters				
	Number of lanes	3	1	3	2
	Average lane width (ft)	12.5	12.5	16	25
	Design speed (mph)	17/25			
	Highway type (see Figures 2-5)	Urban Artery			
8.	Intersection parameters				
	Intersection designation				
	Approach width (ft)				
	Percentage right turns	0	100	100	0
	Percentage left turns	0	0	0	0 — No conflicts.
	Type control and description of signal controller	Signalized			
9.	Area source parameters				
	Parking lot gate designation				
	Projected 1-hr peak entrance demand (vph)				
	Projected 1-hr peak exit demand (vph)				
	Projected 8-hr peak entrance demand (vph)				
	Projected 8-hr peak exit demand (vph)				
	Parking lot area (m^2)				
	Parking lot capacity (veh)				
	Running time required to access auxiliary parking (s)				
	Facility emptying time				
	Average cars per stall				
	Average area per stall (m^2)				

* ANS - Atlantic Ave - NB - Straight
ANR - " " " - Right
NW - Northern Ave - WB
RE - Ramp - EB

WORKSHEET 1 - TRAFFIC INFORMATION

Intersection Atlantic / Northern

Case # 3 Year 1999 - Build

1.	Road segment or intersection approach identification	ANS	ANR	NW	RE
2.	Observed 1-hr volume (vph)				
	Observed 8-hr volume (vph)				
	Projected 1-hr peak demand (vph)	995	1183	694	801
	Projected 8-hr peak demand (vph)	816	970	570	657
3.	Percentage cold starts	50/20.6			
4.	Percentage trucks and buses	6.0	6.0	18	6.0
5.	Metropolitan population				
6.	Slope				
7.	Free-flow parameters				
	Number of lanes	3	1	3	2
	Average lane width (ft)	12.5	12.5	16	25
	Design speed (mph)	17/25			
	Highway type (see Figures 2-5)	Urban Arterial			
8.	Intersection parameters				
	Intersection designation				
	Approach width (ft)				
	Percentage right turns	0	100	100	0
	Percentage left turns	0	0	0	0 — No conflict
	Type control and description of signal controller				
9.	Area source parameters				
	Parking lot gate designation				
	Projected 1-hr peak entrance demand (vph)				
	Projected 1-hr peak exit demand (vph)				
	Projected 8-hr peak entrance demand (vph)				
	Projected 8-hr peak exit demand (vph)				
	Parking lot area (m^2)				
	Parking lot capacity (veh)				
	Running time required to access auxiliary parking (s)				
	Facility emptying time				
	Average cars per stall				
	Average area per stall (m^2)				

WORKSHEET B - CAPACITY ANALYSIS

Intersection Atlantic/Northern

Case # 1 Year 1984

Step	Symbol	Input/Units				
1	i	Road segment (or approach) designation	NW			
2		Free flow capacity computation:				
2.1	M_i	Number of lanes				
2.2	W_f	Adjustment for lane width (Table B-1)				
2.3	T_i	Adjustment for trucks (Table B-2)				
2.4	C_i	Free flow capacity				
3		Signalized intersection capacity:				
3.1	j	Green signal phase identification				
3.2	Wa_i	Approach width with parking (ft)				
3.3		Percent right turners				
3.4		Percent left turners				
3.5		Metropolitan area size				
3.6	$Cs_{i,j}$	Capacity service volume (vph or green)				
4		Signalized intersection green phase and cycle length:				
4.1	$V_{i,j}$	Demand Volume for approach and phase				
4.2	$V_{i,j}/Cs_{i,j})$	Volume to green capacity ratio				
4.3	approx G/Cy	Approximate G/Cy				
4.4	$\sum_j \max(V_{i,j}Cs_{i,j})$	Sum of the maximum V/C ratios for each signal phase				
4.5	Cy	Signal cycle time (sec)				
4.6	Gj	Green phase length				
4.7	Gj/Cy	Green phase to cycle time ratio				
4.8	$C_{i,j}$	Capacity for approach i phase j				
5		Two-way stop, two-way yield or uncontrolled intersection:				
5.1	V_m+V_n	Major street two-way volume	1144/938			
5.2	C_i	Cross street capacity (1hr/8hr)	$\boxed{1464}$/1706			
6		Four-way stop intersections:				
6.1	V_i	Approach volume				
6.2	Spi	Demand split on cross streets				
6.3	C_i	Capacity of approach				
7	C_i	Approach capacity $\sum_j C_{i,j}$ 5.2 for a four-way stop or 6.3 for a two-way stop				

Atlantic Ave (excluding right turns)

Northern Ave Lane	Conflicts with Atlantic Lane	VPH	a	e^{-a}	Ci
1	2	1100*/902**	1.375/1.128	0.253/0.324	372/432
2	2	1100/902	"	"	372/432
3	3	1144/938	1.43/1.17	0.239/0.31	360/421
4	3	1144/938	"	"	360/421
				Total	1464/1706

* 1hr

** 8hr

$$C_i = \frac{Ve^{-a}}{1-e^{-a}} \text{ where } a = Vt/3600,\ t = 4.5 \text{ sec}$$

1.375/

WORKSHEET B - CAPACITY ANALYSIS

Intersection Atlantic/Northern

Case # 2,3 Year 199[illegible]

Step	Symbol	Input/Units	ANS	ANR	NW	RE
1	i	Road segment (or approach) designation	ANS	ANR	NW	RE
2		Free flow capacity computation:				
2.1	M_i	Number of lanes				
2.2	W_f	Adjustment for lane width (Table B-1)				
2.3	T_i	Adjustment for trucks (Table B-2)				
2.4	C_i	Free flow capacity				
3		Signalized intersection capacity:				
3.1	j	Green signal phase identification	ΦA		ØC	ØB
3.2	Wa_i	Approach width with parking (ft)	46		56	58
3.3		Percent right turners	0		100	0
3.4		Percent left turners	0		0	0
3.5		Metropolitan area size	2.5 M			
3.6	$Cs_{i,j}$	Capacity service volume (vph or green)	4800		5500	6400
4		Signalized intersection green phase and cycle length:				
4.1	$V_{i,j}$	Demand Volume for approach and phase				
4.2	$V_{i,j}/Cs_{i,j})$	Volume to green capacity ratio				
4.3	approx G/Cy	Approximate G/Cy				
4.4	$\sum_j \max(V_{i,j}Cs_{i,j})$	Sum of the maximum V/C ratios for each signal phase				
4.5	Cy	Signal cycle time (sec)				
4.6	Gj	Green phase length				
4.7	Gj/Cy	Green phase to cycle time ratio				
4.8	$C_{i,j}$	Capacity for approach i phase j				
5		Two-way stop, two-way yield or uncontrolled intersection:	ANR			
5.1	V_m+V_n	Major street two-way volume	542/444			
5.2	C_i	Cross street capacity (1 hr/8 hr)	1543/1587			
6		Four-way stop intersections:				
6.1	V_i	Approach volume				
6.2	Spi	Demand split on cross streets				
6.3	C_i	Capacity of approach				
7	C_i	Approach capacity $\sum_j C_{i,j}$ 5.2 for a four-way stop or 6.3 for a two-way stop				

18% trucks [illegible]

No opposing traffic

	VPH	a^*	e^{-a}	C_i
1 hr	542	0.30	0.74	1543
8 hr	444	0.25	0.78	1587

$^*a = Vt/3600$, Use t=2 sec critical gap since it is a green signal for all phases - use to simulate a slow down with minimal conflicts from off ramp flow to Northern Ave EB

WORKSHEET 2 - LINE SOURCE EMISSION RATE COMPUTATION

Intersection Atlantic / Northern

Case # 1 Year 1986 Averaging Time 1-Hour

Step	Symbol	Input/Units	Traffic Stream			
1	i	Road segment (or approach identification)	NW			
2	V_i	Demand volume (vph)	540			
3	C_i	Free-flow capacity (vph)				
4	S_i	Cruise speed (mph)	17			
5	Ef_i	Free-flow emissions (g/veh-m)	0			
6.1	M_i	Number of lanes in approach i	4			
6.2	j	Signalized intersections phase identification				
6.3	$Cs_{i,j}$	Capacity service volume of approach i for phase j (vph of green)				
6.4	$V_{i,j}$	Demand volume for approach i, phase j (vph)				
6.5	C_y	Signal cycle length (s)				
6.6	$G_{i,j}$	Green phase length for approach i, phase j (s)				
6.7	C_i	Capacity of approach i (vph))	1464			
6.8	$P_{i,j}$	Proportion of vehicles that stop				
6.9	$N_{i,j}$	Number of vehicles that stop per signal cycle				
7	N_i	Average number of vehicles in queue at four way stop or two-way stop or end of green phase				
8	Lq_i	Length of vehicle queue for approach i (veh-m/lane)	1.6			
9	Rq_i	Average excess running time on approach (s/veh)				
10	Ea_i	emissions from acceleration (g/veh-m)				
11	Ed_i	emissions from deceleration (g/veh-m)				
12	Qad_i	emission rate from acceleration and deceleration (g/m-s)				
13	Lad_i	Length of acceleration and deceleration (m)				
14	Le_i	Length over which excess emissions apply (m)				
15	Fs_i	Average idling emission rate (g/s)				
16	Qe	Average emission rate (g/m-s)				
17	Qe_i	Adjusted excess emission rate (g/s-m)				
18	Qfc_i	Free-flow emission rate (g/s-m)				

WORKSHEET 2 - LINE SOURCE EMISSION RATE COMPUTATION

Intersection Atlantic/Northern

Case # 1 Year 1986 Averaging Time 8-Hour

Step	Symbol	Input/Units	Traffic Stream
1	i	Road segment (or approach identification)	NW
2	V_i	Demand volume (vph)	443
3	C_i	Free-flow capacity (vph)	
4	S_i	Cruise speed (mph)	25
5	Ef_i	Free-flow emissions (g/veh-m)	0
6.1	M_i	Number of lanes in approach i	4
6.2	j	Signalized intersections phase identification	
6.3	$Cs_{i,j}$	Capacity service volume of approach i for phase j (vph of green)	
6.4	$V_{i,j}$	Demand volume for approach i, phase j (vph)	
6.5	C_y	Signal cycle length (s)	
6.6	$G_{i,j}$	Green phase length for approach i, phase j (s)	
6.7	C_i	Capacity of approach i (vph))	1706
6.8	$P_{i,j}$	Proportion of vehicles that stop	
6.9	$N_{i,j}$	Number of vehicles that stop per signal cycle	
7	N_i	Average number of vehicles in queue at four way stop or two-way stop or end of green phase	
8	Lq_i	Length of vehicle queue for approach i (veh-m/lane)	1.0
9	Rq_i	Average excess running time on approach (s/veh)	
10	Ea_i	emissions from acceleration (g/veh-m)	
11	Ed_i	emissions from deceleration (g/veh-m)	
12	Qad_i	emission rate from acceleration and deceleration (g/m-s)	
13	Lad_i	Length of acceleration and deceleration (m)	
14	Le_i	Length over which excess emissions apply (m)	
15	Fs_i	Average idling emission rate (g/s)	
16	Qe	Average emission rate (g/m-s)	
17	Qe_i	Adjusted excess emission rate (g/s-m)	
18	Qfc_i	Free-flow emission rate (g/s-m)	

WORKSHEET 2 - LINE SOURCE EMISSION RATE COMPUTATION

Intersection Atlantic / Northern

Case # 2 Year 1994 Averaging Time 1 - Hour

Step	Symbol	Input/Units	Traffic Stream			
1	i	Road segment (or approach identification)	ANS	ANR	NW	RE
2	V_i	Demand volume (vph)	995	1183	667	801
3	C_i	Free-flow capacity (vph)				
4	S_i	Cruise speed (mph)	17	17	17	17
5	Ef_i	Free-flow emissions (g/veh-m)	0	0	0	6
6.1	M_i	Number of lanes in approach i	3	1	3	2
6.2	j	Signalized intersections phase identification	A		C	B
6.3	$Cs_{i,j}$	Capacity service volume of approach i for phase j (vph of green)	4800	1543	5500	6?00
6.4	$V_{i,j}$	Demand volume for approach i, phase j (vph)	995		664	801
6.5	C_y	Signal cycle length (s)	90			
6.6	$G_{i,j}$	Green phase length for approach i, phase j (s)	25		52	13
6.7	C_i	Capacity of approach i (vph)	1333		3178	927
6.8	$P_{i,j}$	Proportion of vehicles that stop	0.91		0.48	0.98
6.9	$N_{i,j}$	Number of vehicles that stop per signal cycle	22.7		8.0	19.6
7	N_i	Average number of vehicles in queue at four way stop or two-way stop or end of green phase	2.9		0.3	6.5
8	Lq_i	Length of vehicle queue for approach i (veh-m/lane)	51.2	36.3	16.5	78.2
9	Rq_i	Average excess running time on approach (s/veh)				
10	Ea_i	emissions from acceleration (g/veh-m)				
11	Ed_i	emissions from deceleration (g/veh-m)				
12	Qad_i	emission rate from acceleration and deceleration (g/m-s)				
13	Lad_i	Length of acceleration and deceleration (m)				
14	Le_i	Length over which excess emissions apply (m)				
15	Fs_i	Average idling emission rate (g/s)				
16	Qe	Average emission rate (g/m-s)				
17	Qe_i	Adjusted excess emission rate (g/s-m)				
18	Qfc_i	Free-flow emission rate (g/s-m)				

WORKSHEET 2 - LINE SOURCE EMISSION RATE COMPUTATION

Intersection Atlantic / Northern

Case # 2 Year 1994 Averaging Time 8 - Hour

Step	Symbol	Input/Units	Traffic Stream			
1	i	Road segment (or approach identification)	ANS	ANR	NW	RE
2	V_i	Demand volume (vph)	816	970	545	657
3	C_i	Free-flow capacity (vph)				
4	S_i	Cruise speed (mph)	25	25	25	25
5	Ef_i	Free-flow emissions (g/veh-m)	0	0	0	0
6.1	M_i	Number of lanes in approach i	3	1	3	2
6.2	j	Signalized intersections phase identification				
6.3	$Cs_{i,j}$	Capacity service volume of approach i for phase j (vph of green)	4800	1587	5500	6400
6.4	$V_{i,j}$	Demand volume for approach i, phase j (vph)	816	970	575	657
6.5	C_y	Signal cycle length (s)	90			
6.6	$G_{i,j}$	Green phase length for approach i, phase j (s)	25		52	13
6.7	C_i	Capacity of approach i (vph))	1333		3175	924
6.8	$P_{i,j}$	Proportion of vehicles that stop	0.87		0.47	0.95
6.9	$N_{i,j}$	Number of vehicles that stop per signal cycle	17.8		6.4	15.7
7	N_i	Average number of vehicles in queue at four way stop or two-way stop or end of green phase	1.6		0 2	2.5
8	Lq_i	Length of vehicle queue for approach i (veh-m/lane)	38.7	17.4	13.2	57.4
9	Rq_i	Average excess running time on approach (s/veh)				
10	Ea_i	emissions from acceleration (g/veh-m)				
11	Ed_i	emissions from deceleration (g/veh-m)				
12	Qad_i	emission rate from acceleration and deceleration (g/m-s)				
13	Lad_i	Length of acceleration and deceleration (m)				
14	Le_i	Length over which excess emissions apply (m)				
15	Fs_i	Average idling emission rate (g/s)				
16	Qe	Average emission rate (g/m-s)				
17	Qe_i	Adjusted excess emission rate (g/s-m)				
18	Qfc_i	Free-flow emission rate (g/s-m)				

WORKSHEET 2 - LINE SOURCE EMISSION RATE COMPUTATION

Intersection Atlantic /Northern

Case # 3 Year 1994 Averaging Time 1-Hour

Step	Symbol	Input/Units	Traffic Stream			
1	i	Road segment (or approach identification)	ANS	ANR	NW	RF
2	V_i	Demand volume (vph)	995	1183	694	801
3	C_i	Free-flow capacity (vph)				
4	S_i	Cruise speed (mph)	17	17	17	17
5	Ef_i	Free-flow emissions (g/veh-m)	0	0	0	0
6.1	M_i	Number of lanes in approach i	3	1	3	2
6.2	j	Signalized intersections phase identification	A		C	B
6.3	$Cs_{i,j}$	Capacity service volume of approach i for phase j (vph of green)	4800	1543	5500	6400
6.4	$V_{i,j}$	Demand volume for approach i, phase j (vph)	995		564	501
6.5	C_y	Signal cycle length (s)	90			
6.6	$G_{i,j}$	Green phase length for approach i, phase j (s)	25		52	13
6.7	C_i	Capacity of approach i·(vph))	1333		3178	924
6.8	$P_{i,j}$	Proportion of vehicles that stop	0,91		0,48	0,98
6.9	$N_{i,j}$	Number of vehicles that stop per signal cycle	22,7		8,0	19.6
7	N_i	Average number of vehicles in queue at four way stop or two-way stop or end of green phase	2,9		0.3	6.5
8	Lq_i	Length of vehicle queue for approach i (veh-m/lane)	51.2	36.3	17.3	73.2
9	Rq_i	Average excess running time on approach (s/veh)				
10	Ea_i	emissions from acceleration (g/veh-m)				
11	Ed_i	emissions from deceleration (g/veh-m)				
12	Qad_i	emission rate from acceleration and deceleration (g/m-s)				
13	Lad_i	Length of acceleration and deceleration (m)				
14	Le_i	Length over which excess emissions apply (m)				
15	Fs_i	Average idling emission rate (g/s)				
16	Qe	Average emission rate (g/m-s)				
17	Qe_i	Adjusted excess emission rate (g/s-m)				
18	Qfc_i	Free-flow emission rate (g/s-m)				

WORKSHEET 2 - LINE SOURCE EMISSION RATE COMPUTATION

Intersection Atlantic / Northern

Case # 3 Year 1994 Averaging Time 8 - Hour

Step	Symbol	Input/Units	Traffic Stream			
1	i	Road segment (or approach identification)	ANS	ANR	NW	RE
2	V_i	Demand volume (vph)	816	970	570	657
3	C_i	Free-flow capacity (vph)				
4	S_i	Cruise speed (mph)	25	25	25	25
5	Ef_i	Free-flow emissions (g/veh-m)	0	0	0	0
6.1	M_i	Number of lanes in approach i	3	1	3	2
6.2	j	Signalized intersections phase identification				
6.3	$Cs_{i,j}$	Capacity service volume of approach i for phase j (vph of green)	4800	1587	5500	6400
6.4	$V_{i,j}$	Demand volume for approach i, phase j (vph)	816	970	570	657
6.5	C_y	Signal cycle length (s)	90			
6.6	$G_{i,j}$	Green phase length for approach i, phase j (s)	25		52	13
6.7	C_i	Capacity of approach i (vph))	1333		3178	924
6.8	$P_{i,j}$	Proportion of vehicles that stop	0.37		0.47	0.95
6.9	$N_{i,j}$	Number of vehicles that stop per signal cycle	17.8		6.7	15.7
7	N_i	Average number of vehicles in queue at four way stop or two-way stop or end of green phase	1.6		0.2	2.5
8	Lq_i	Length of vehicle queue for approach i (veh-m/lane)	387	17.4	13.8	54.4
9	Rq_i	Average excess running time on approach (s/veh)				
10	Ea_i	emissions from acceleration (g/veh-m)				
11	Ed_i	emissions from deceleration (g/veh-m)				
12	Qad_i	emission rate from acceleration and deceleration (g/m-s)				
13	Lad_i	Length of acceleration and deceleration (m)				
14	Le_i	Length over which excess emissions apply (m)				
15	Fs_i	Average idling emission rate (g/s)				
16	Qe	Average emission rate (g/m-s)				
17	Qe_i	Adjusted excess emission rate (g/s-m)				
18	Qfc_i	Free-flow emission rate (g/s-m)				

WORKSHEET 1 - TRAFFIC INFORMATION

Intersection Purchase / Oliver.

Case # 1 Year 1986

1.	Road segment or intersection approach identification	PS*	OS*
2.	Observed 1-hr volume (vph)	691	526
	Observed 8-hr volume (vph)	518	310
	Projected 1-hr peak demand (vph)		
	Projected 8-hr peak demand (vph)		
3.	Percentage cold starts	50/20.6	
4.	Percentage trucks and buses	5.5	
5.	Metropolitan population		
6.	Slope		
7.	Free-flow parameters		
	Number of lanes	3	1
	Average lane width (ft)	12	25
	Design speed (mph) (1hr/8hr)	20/30	20/30
	Highway type (see Figures 2-5)	Urban Artery.	
8.	Intersection parameters		
	Intersection designation		
	Approach width (ft)	36	25
	Percentage right turns	0	100
	Percentage left turns	0	0
	Type control and description of signal controller	STOP Sign.	
9.	Area source parameters		
	Parking lot gate designation		
	Projected 1-hr peak entrance demand (vph)		
	Projected 1-hr peak exit demand (vph)		
	Projected 8-hr peak entrance demand (vph)		
	Projected 8-hr peak exit demand (vph)		
	Parking lot area (m^2)		
	Parking lot capacity (veh)		
	Running time required to access auxiliary parking (s)		
	Facility emptying time		
	Average cars per stall		
	Average area per stall (m^2)		

PS = Purchase St.

OS = Oliver St

WORKSHEET 1 - TRAFFIC INFORMATION

Intersection Purchase / Oliver / off Ramp

Case # 2 Year 1994

1.	Road segment or intersection approach identification	OS	OR
2.	Observed 1-hr volume (vph)		
	Observed 8-hr volume (vph)		
	Projected 1-hr peak demand (vph)	21	2110
	Projected 8-hr peak demand (vph)	12	1583
3.	Percentage cold starts	50/20.6	
4.	Percentage trucks and buses	5.5	
5.	Metropolitan population		
6.	Slope		
7.	Free-flow parameters		
	Number of lanes	1	2
	Average lane width (ft)	25	11
	Design speed (mph)	20/30	17/25
	Highway type (see Figures 2-5)	Urban Arterial	
8.	Intersection parameters		
	Intersection designation		
	Approach width (ft)	25	22
	Percentage right turns	100	0
	Percentage left turns	0	0
	Type control and description of signal controller	Stop Sign	
9.	Area source parameters		
	Parking lot gate designation		
	Projected 1-hr peak entrance demand (vph)		
	Projected 1-hr peak exit demand (vph)		
	Projected 8-hr peak entrance demand (vph)		
	Projected 8-hr peak exit demand (vph)		
	Parking lot area (m^2)		
	Parking lot capacity (veh)		
	Running time required to access auxiliary parking (s)		
	Facility emptying time		
	Average cars per stall		
	Average area per stall (m^2)		

OS = Oliver St
OR = off Ramp

WORKSHEET 1 - TRAFFIC INFORMATION

Intersection Parkwood/Olive-1 off Ramp

Case # 3 Year 1992

1.	Road segment or intersection approach identification	05		OR				
2.	Observed 1-hr volume (vph)							
	Observed 8-hr volume (vph)							
	Projected 1-hr peak demand (vph)	21		2251				
	Projected 8-hr peak demand (vph)	12		1688				
3.	Percentage cold starts	50/20.6						
4.	Percentage trucks and buses	5.5						
5.	Metropolitan population							
6.	Slope							
7.	Free-flow parameters							
	Number of lanes	1		2				
	Average lane width (ft)	25		11				
	Design speed (mph)	20/30		15/25				
	Highway type (see Figures 2-5)	Urban Artery						
8.	Intersection parameters							
	Intersection designation							
	Approach width (ft)	25		22				
	Percentage right turns	100		0				
	Percentage left turns	0		0				
	Type control and description of signal controller	Stop Sign						
9.	Area source parameters							
	Parking lot gate designation							
	Projected 1-hr peak entrance demand (vph)							
	Projected 1-hr peak exit demand (vph)							
	Projected 8-hr peak entrance demand (vph)							
	Projected 8-hr peak exit demand (vph)							
	Parking lot area (m^2)							
	Parking lot capacity (veh)							
	Running time required to access auxiliary parking (s)							
	Facility emptying time							
	Average cars per stall							
	Average area per stall (m^2)							

WORKSHEET B - CAPACITY ANALYSIS

Intersection Purchase/Oliver

Case # 1. Year 1986

Step	Symbol	Input/Units				
1	i	Road segment (or approach) designation	PS		OS.	
2		Free flow capacity computation:				
2.1	M_i	Number of lanes	1		1	
2.2	W_f	Adjustment for lane width (Table B-1)				
2.3	T_i	Adjustment for trucks (Table B-2)				
2.4	C_i	Free flow capacity				
3		Signalized intersection capacity:				
3.1	j	Green signal phase identification				
3.2	Wa_i	Approach width with parking (ft)				
3.3		Percent right turners				
3.4		Percent left turners				
3.5		Metropolitan area size				
3.6	$Cs_{i,j}$	Capacity service volume (vph or green)				
4		Signalized intersection green phase and cycle length:				
4.1	$V_{i,j}$	Demand Volume for approach and phase				
4.2	$V_{i,j}/Cs_{i,j})$	Volume to green capacity ratio				
4.3	approx G/Cy	Approximate G/Cy				
4.4	$\Sigma_j \max(V_{i,j}Cs_{i,j})$	Sum of the maximum V/C ratios for each signal phase				
4.5	Cy	Signal cycle time (sec)				
4.6	Gj	Green phase length				
4.7	Gj/Cy	Green phase to cycle time ratio				
4.8	$C_{i,j}$	Capacity for approach i phase j				
5		Two-way stop, two-way yield or uncontrolled intersection:				
5.1	V_m+V_n	Major street two-way volume (1hr/8hr)	346/259			
5.2	C_i	Cross street capacity			643/676	
6		Four-way stop intersections:				
6.1	V_i	Approach volume				
6.2	Spi	Demand split on cross streets				
6.3	C_i	Capacity of approach				
7	C_i	Approach capacity $\Sigma_j C_{i,j}$ 5.2 for a four-way stop or 6.3 for a two-way stop				

Assume Opposing Traffic from ½ of Purchase Traffic in only 1 lane of 3 available.

$$C_i = \frac{Ve^{-a}}{1-e^{-a}}$$

$a = Vt/3600$, $t = 4.5$ sec.
$V = V_m + V_n$

$V = 346$, $a = 0.433$, $e^{-a} = 0.65$

$$C_i = \frac{346 \times 0.65}{1-0.65} = 643$$

$V = 259$ $a = 0.324$, $e^{-a} = 0.723$

$$C_i = \frac{259 \times 0.723}{1-0.723} = 676$$

WORKSHEET B - CAPACITY ANALYSIS

Intersection Purchase/Oliver/Off Ramp.

Case # 2,3 Year 1994

Step	Symbol	Input/Units	No build		Build	
1	i	Road segment (or approach) designation	OR	OS	OR	OS
2		Free flow capacity computation:				
2.1	M_i	Number of lanes	1	1	1	1
2.2	W_f	Adjustment for lane width (Table B-1)				
2.3	T_i	Adjustment for trucks (Table B-2)				
2.4	C_i	Free flow capacity				
3		Signalized intersection capacity:				
3.1	j	Green signal phase identification				
3.2	Wa_i	Approach width with parking (ft)				
3.3		Percent right turners				
3.4		Percent left turners				
3.5		Metropolitan area size				
3.6	$Cs_{i,j}$	Capacity service volume (vph or green)				
4		Signalized intersection green phase and cycle length:				
4.1	$V_{i,j}$	Demand Volume for approach and phase				
4.2	$V_{i,j}/Cs_{i,j})$	Volume to green capacity ratio				
4.3	approx G/Cy	Approximate G/Cy				
4.4	$\sum_j \max(V_{i,j}Cs_{i,j})$	Sum of the maximum V/C ratios for each signal phase				
4.5	Cy	Signal cycle time (sec)				
4.6	Gj	Green phase length				
4.7	Gj/Cy	Green phase to cycle time ratio				
4.8	$C_{i,j}$	Capacity for approach i phase j				
5		Two-way stop, two-way yield or uncontrolled intersection:				
5.1	V_m+V_n	Major street two-way volume (1hr/shr)	1055/792		1126/844	
5.2	C_i	Cross street capacity		385/469		365/95
6		Four-way stop intersections:				
6.1	V_i	Approach volume				
6.2	Spi	Demand split on cross streets				
6.3	C_i	Capacity of approach				
7	C_i	Approach capacity $\sum_j C_{i,j}$ 5.2 for a four-way stop or 6.3 for a two-way stop				

Assume Opposing Traffic
from ½ of off Ramp in
1 lane of 2 available

$V = 1055$, $a = 1.32$, $e^{-a} = 0.268$, $C_i = 385$
$V = 792$, $a = 0.99$, $e^{-a} = 0.372$, $C_i = 467$
$V = 1126$, $a = 1.41$, $e^{-a} = 0.245$, $C_i = 365$
$V = 844$, $a = 1.06$, $e^{-a} = 0.348$, $C_i = 451$

WORKSHEET 2 - LINE SOURCE EMISSION RATE COMPUTATION

Intersection Purchase / Oliver

Case # 1 Year 1980 Averaging Time 1 Hour

Step	Symbol	Input/Units	Traffic Stream
1	i	Road segment (or approach identification)	05
2	V_i	Demand volume (vph)	526
3	C_i	Free-flow capacity (vph)	
4	S_i	Cruise speed (mph)	
5	Ef_i	Free-flow emissions (g/veh-m)	
6.1	M_i	Number of lanes in approach i	1
6.2	j	Signalized intersections phase identification	
6.3	$Cs_{i,j}$	Capacity service volume of approach i for phase j (vph of green)	
6.4	$V_{i,j}$	Demand volume for approach i, phase j (vph)	
6.5	C_y	Signal cycle length (s)	
6.6	$G_{i,j}$	Green phase length for approach i, phase j (s)	
6.7	C_i	Capacity of approach i·(vph))	643
6.8	$P_{i,j}$	Proportion of vehicles that stop	
6.9	$N_{i,j}$	Number of vehicles that stop per signal cycle	
7	N_i	Average number of vehicles in queue at four way stop or two-way stop or end of green phase	4.5
8	Lq_i	Length of vehicle queue for approach i (veh-m/lane)	26.97
9	Rq_i	Average excess running time on approach (s/veh)	
10	Ea_i	emissions from acceleration (g/veh-m)	
11	Ed_i	emissions from deceleration (g/veh-m)	
12	Qad_i	emission rate from acceleration and deceleration (g/m-s)	
13	Lad_i	Length of acceleration and deceleration (m)	
14	Le_i	Length over which excess emissions apply (m)	
15	Fs_i	Average idling emission rate (g/s)	
16	Qe	Average emission rate (g/m-s)	
17	Qe_i	Adjusted excess emission rate (g/s-m)	
18	Qfc_i	Free-flow emission rate (g/s-m)	

WORKSHEET 2 - LINE SOURCE EMISSION RATE COMPUTATION

Intersection Purchase/Oliver

Case # 1 Year 1986 Averaging Time 8 Hour

Step	Symbol	Input/Units	Traffic Stream			
1	i	Road segment (or approach identification)	OS			
2	V_i	Demand volume (vph)	310			
3	C_i	Free-flow capacity (vph)				
4	S_i	Cruise speed (mph)				
5	Ef_i	Free-flow emissions (g/veh-m)				
6.1	M_i	Number of lanes in approach i	1			
6.2	j	Signalized intersections phase identification				
6.3	$Cs_{i,j}$	Capacity service volume of approach i for phase j (vph of green)				
6.4	$V_{i,j}$	Demand volume for approach i, phase j (vph)				
6.5	C_y	Signal cycle length (s)				
6.6	$G_{i,j}$	Green phase length for approach i, phase j (s)				
6.7	C_i	Capacity of approach i·(vph))	676			
6.8	$P_{i,j}$	Proportion of vehicles that stop				
6.9	$N_{i,j}$	Number of vehicles that stop per signal cycle				
7	N_i	Average number of vehicles in queue at four way stop or two-way stop or end of green phase	0.85			
8	Lq_i	Length of vehicle queue for approach i (veh-m/lane)	5.08 *			
9	Rq_i	Average excess running time on approach (s/veh)				
10	Ea_i	emissions from acceleration (g/veh-m)				
11	Ed_i	emissions from deceleration (g/veh-m)				
12	Qad_i	emission rate from acceleration and deceleration (g/m-s)				
13	Lad_i	Length of acceleration and deceleration (m)				
14	Le_i	Length over which excess emissions apply (m)				
15	Fs_i	Average idling emission rate (g/s)				
16	Qe	Average emission rate (g/m-s)				
17	Qe_i	Adjusted excess emission rate (g/s-m)				
18	Qfc_i	Free-flow emission rate (g/s-m)				

* Q link must be at least as long as wide - At 8 M wide - Assume no Q.

WORKSHEET 2 - LINE SOURCE EMISSION RATE COMPUTATION

Intersection Purchase / Olivera

Case # 2,3 Year 1994 Averaging Time 1- Hour
8- Hour

Step	Symbol	Input/Units	Traffic Stream			
1	i	Road segment (or approach identification)	PS			
2	V_i	Demand volume (vph)	21			
3	C_i	Free-flow capacity (vph)				
4	S_i	Cruise speed (mph)				
5	Ef_i	Free-flow emissions (g/veh-m)				
6.1	M_i	Number of lanes in approach i	1			
6.2	j	Signalized intersections phase identification				
6.3	$Cs_{i,j}$	Capacity service volume of approach i for phase j (vph of green)				
6.4	$V_{i,j}$	Demand volume for approach i, phase j (vph)				
6.5	C_y	Signal cycle length (s)				
6.6	$G_{i,j}$	Green phase length for approach i, phase j (s)				
6.7	C_i	Capacity of approach i·(vph))	385			
6.8	$P_{i,j}$	Proportion of vehicles that stop				
6.9	$N_{i,j}$	Number of vehicles that stop per signal cycle				
7	N_i	Average number of vehicles in queue at four way stop or two-way stop or end of green phase	0.06			
8	Lq_i	Length of vehicle queue for approach i (veh-m/lane)	0.35 *			
9	Rq_i	Average excess running time on approach (s/veh)				
10	Ea_i	emissions from acceleration (g/veh-m)				
11	Ed_i	emissions from deceleration (g/veh-m)				
12	Qad_i	emission rate from acceleration and deceleration (g/m-s)				
13	Lad_i	Length of acceleration and deceleration (m)				
14	Le_i	Length over which excess emissions apply (m)				
15	Fs_i	Average idling emission rate (g/s)				
16	Qe	Average emission rate (g/m-s)				
17	Qe_i	Adjusted excess emission rate (g/s-m)				
18	Qfc_i	Free-flow emission rate (g/s-m)				

* Negligible - worst case of 1994 options, therefore, other cases also negligible.

WORKSHEET 3 - AREA SOURCE EMISSIONS COMPUTATION

Area Source: 25 [illegible] Street Parking Garage

Case #: [illegible] Year: [illegible] Averaging Time: 1 Hour

Step	Symbol	Input/Units	Traffic Stream			
1	Brt	Base running time				
1.1		Base approach time(s)	1.0			
1.2		Base entrance time(s)	5.0			
1.3		Base movement-in time(s)	75.0			
1.4		Base stop, base start time(s)	10.0			
1.5		Base movement-out time(s)	75.0			
1.6		Base exit time(s)	5.0			
1.7		Base departure time(s)	1.0			
1.8		Total base running time(s)	172			
2	A	Area of parking lot (m^2)				
3	i	Entrance approach identification				
4	Ve_i	Entrance demand volume (vph)	38			
5	Ce_i	Entrance approach capacities (vph)	720			
6	i	Exit approach identification				
7	Vx_i	Exit demand volume (vph)		622		
8	Cx_i	Exit approach capacities (vph) *		759		
9		Number of parking spaces occupied				
10	F	Emissions g/veh-hr		103.11		
11	Pc	Capacity of parking lot (veh)	350			
12	Rmi	Excess movement-in time(s)	0			
13	Fet	Facility emptying time(s)	8500			
14		Excess running time				
14.1	Ve_i/Ce_i	Entering volume-to-capacity ratio	0.05			
14.2	Vx_i/Cx_i	Exiting volume-to-capacity ratio		0.82		
14.3	Re_i	Excess running time entering parking lot	0.3			
14.4	Rx_i	Excess running time exiting parking lot		21.5		
15	Te_i	Total entering running time (s/veh)	88.8			
16	Rmo	Excess running time moving out of parking stalls (s/veh)	0			
17	Tx_i	Total exiting running time (s/veh)		107.5		
18	Qa	~~Total emission rate from a parking lot (g/m^2 - s)~~ [illegible] rate (g/s)	8.38			
19	Qa'	Area source emission rate without the emissions from internal road segment. i				

2 lanes.

$$* \; C_i = \frac{V e^{-a}}{1-e^{-a}}$$

a = [illegible] / 3600

V = 2237 VPH / 3 lanes = 746 veh lane 1

a = 0.[illegible]

[illegible] 0.[illegible]

C_i = 485

C_{iT} = 485 274 = 759

1492 VPH / 2 lanes

[illegible] 1492/[illegible]

e^{-a} = 0.155

C_i = 273.5

$$Re_i = \frac{38}{720-38} \times \frac{3600}{720} = 0.3$$

$$Rx_i = \frac{622}{759-622} \cdot \frac{3600}{759} \quad 21.5$$

Q_a = [(Te × Ve × F) + (Tx × [illegible])] [illegible] ($\frac{1 hr}{3600 sec}$) = 8.38

WORKSHEET 3 - AREA SOURCE EMISSIONS COMPUTATION

Area Source 125 High Street Parking Garage

Case # [illegible] Year [illegible] Averaging Time [illegible] Hour

Step	Symbol	Input/Units	Traffic Stream			
1	Brt	Base running time				
1.1		Base approach time(s)	1.0			
1.2		Base entrance time(s)	5.0			
1.3		Base movement-in time(s)	75.0			
1.4		Base stop, base start time(s)	10.0			
1.5		Base movement-out time(s)	75.0			
1.6		Base exit time(s)	6.			
1.7		Base departure time(s)	[illegible]			
1.8		Total base running time(s)	173			
2	A	Area of parking lot (m^2)				
3	i	Entrance approach identification				
4	Ve_i	Entrance demand volume. (vph)	46			
5	Ce_i	Entrance approach capacities (vph)	720			
6	i	Exit approach identification				
7	Vx_i	Exit demand volume (vph)		119		
8	Cx_i	Exit approach capacities (vph)		559		
9		Number of parking spaces occupied				
10	F	Emissions g/min	49.59			
11	Pc	Capacity of parking lot (veh)				
12	Rmi	Excess movement-in time(s)	3			
13	Fet	Facility emptying time(s)				
14		Excess running time				
14.1	Ve_i/Ce_i	Entering volume-to-capacity ratio	0.064			
14.2	Vx_i/Cx_i	Exiting volume-to-capacity ratio	0.21			
14.3	Re_i	Excess running time entering parking lot	0.34			
14.4	Rx_i	Excess running time exiting parking lot		1.74		
15	Te_i	Total entering running time (s/veh)	76.34			
16	Rmo	Excess running time moving out of parking stalls (s/veh)	0			
17	Tx_i	Total exiting running time (s/veh)		88.74		
18	Qa	Total emission rate from a parking ~~lot (g/m² - s)~~ [illegible] (g/s).	0.83			
19	Qa'	Area source emission rate without the emissions from internal road segment. i				

Exit [illegible] Capacity: 1 lane - $V = 2237 \times 0.75 / [illegible] = 559$

$g = 45 \times 559 / 3600 = 0.70$

$[illegible] \quad 0.50$

$C = \frac{559 \times 0.5}{1 - 0.5} = 559$

$Re = \frac{46}{720-46} \times \frac{3600}{720} = 0.34$

$Rx = \frac{119}{559-119} \times \frac{3600}{559} = 1.74$

$Q = [illegible] \cdot Ve \cdot F) + (Tx \cdot Vx \cdot F) / [illegible] = 0.83$